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VOL. 113 JANUARY, 1941 NO. 1

ANNALS of SURGERY

A MONTHLY REVIEW OF SURGICAL SCIENCE AND PRACTICE

Also the Official Publication of the American Surgical Association; the Southern Surgical Association; Philadelphia Academy of Surgery; and New York Surgical Society

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CONTENTS

Vol. 113 JANUARY, 1941 No. 1

SYMPOSIUM ON INFLAMMATORY LESIONS OF THE COLON

THE SURGICAL TREATMENT OF INTRACTABLE ULCERATIVE COLITIS John H. Garlock, M.D. New York, N. Y. 2

ACUTE DIVERTICULITIS AND SIGMOIDITIS Carl Eggers, M.D. New York, N. Y. 15

LYMPHOGRANULOMA VENEREUM W. Howard Barber, M.D. Wallace B. Murphy, M.D. New York, N. Y. 30

A GASTRIC SECRETORY DEPRESSANT IN EXTRACTS OF ACHLORHYDRIC CARCINOMATOUS STOMACHS Alexander Brunschwig, M.D. T. Howard Clarke, M.D. John van Prohaska, M.D. Robert Schmitz, M.D. Chicago, Ill. 41

SURGICAL EMERGENCIES DURING CHILDHOOD CAUSED BY MECKEL'S DIVERTICULUM Lawrence Chaffin, M.D. Los Angeles, Calif. 47

ACUTE THROMBOCYTOPENIC PURPURA HEMORRHAGICA ASSOCIATED WITH TUBERCULOSIS (MILIARY) OF THE SPLEEN Jerome J. Weiner, M.D. Rupert F. Carter, M.D. New York, N. Y. 57

THE USE OF ERGOTOXINE AND ERGOTAMINE IN THE SURGICAL MANAGEMENT OF THYROTOXICOSIS Donald E. Brace, M.D. L. Corsan Reid, M.D. New York, N. Y. 62

COEXISTING CARCINOMATA OF THYROID AND ABERRANT THYROID WITH REGIONAL METASTASES Arthur S. W. Touroff, M.D. New York, N. Y. 73

PAPILLARY ADENOMA OF ABERRANT THYROID . . Morris K. Smith, M.D. New York, N. Y. 77

SUBSTERNAL THYROID William B. Parsons, M.D. New York, N. Y. 82

AN OSTEOPLASTIC NEUROLYSIS OPERATION FOR THE CURE OF MERALGIA PARESTHETICA . . . Ferdinand C. Lee, M.D. Baltimore, Md. 85

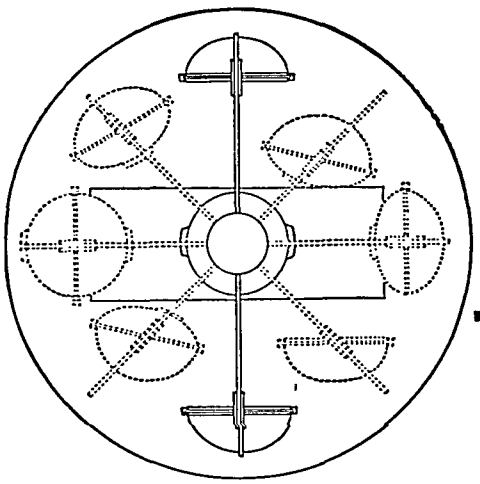
EXTRASKELETAL OSSIFYING TUMORS Harwell Wilson, M.D. Memphis, Tenn. 95

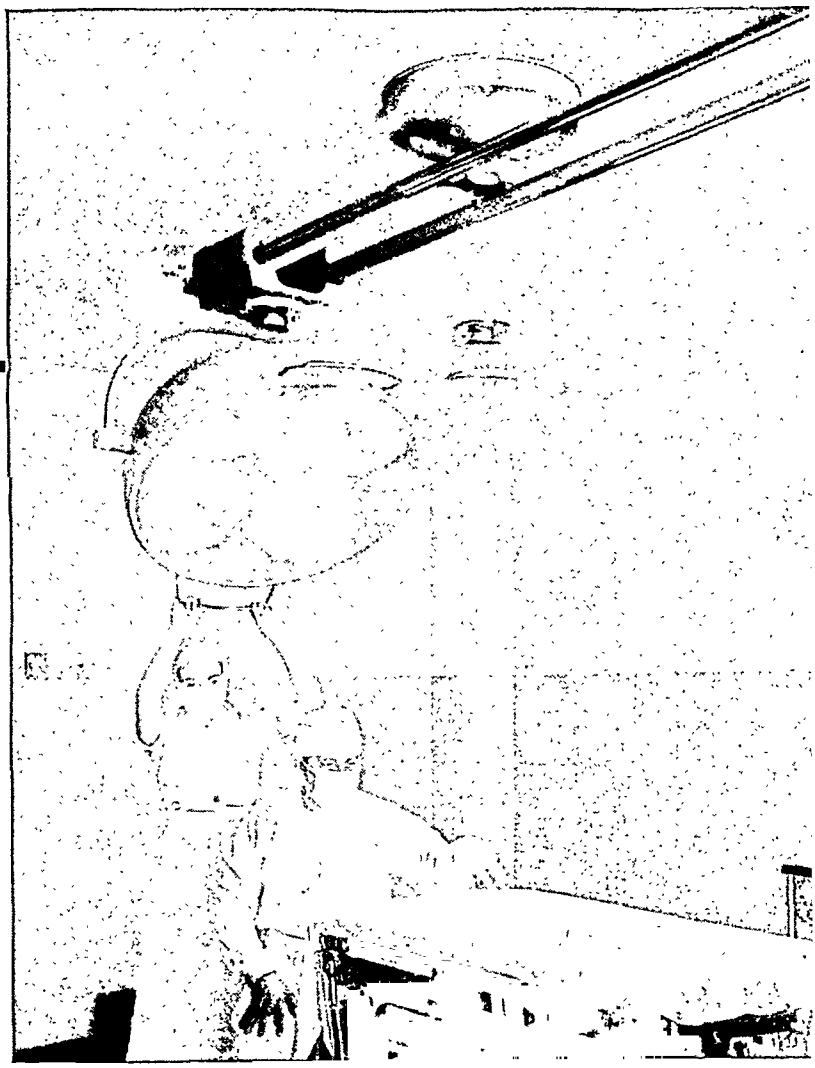
THE TREATMENT OF STAPHYLOCOCCAL CAVERNOUS SINUS THROMBOPHLEBITIS WITH HEPARIN AND CHEMOTHERAPY Champ Lyons, M.D. Boston, Mass. 113

INTRANASAL GRANULOMA OF THE SPOROTHRIX TYPE PRODUCING MARKED NASAL DEFORMITY Marie Ortmayer, M.D. Eleanor M. Humphreys, M.D. Chicago, Ill. 118

(Contents continued on page 4)

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CONTENTS—*Continued*

VARICOCELE AND ITS TREATMENT Homer L. Skinner, M.D.
Baltimore, Md. 123

INDELIBLE PENCIL INJURIES TO THE HANDS .. Michael L. Mason, M.D.
Harvey S. Allen, M.D.
Chicago, Ill. 131

AMEBIASIS CUTIS..... Thomas E. Wyatt, M.D.
Ransom R. Buchholz, M.D.
Nashville, Tenn. 140

BRIEF COMMUNICATION AND CASE REPORT

FREE TRANSPLANTATION OF FAT FOR BRONCHOPULMONARY CAVITY..... Harold Neuhof, M.D.
New York, N. Y. 153

FORUM..... Frederick Christopher, M.D.
Evanston, Ill.
Sumner L. Koch, M.D.
Chicago, Ill.
Hubley R. Owen, M.D.
Philadelphia, Pa. 156

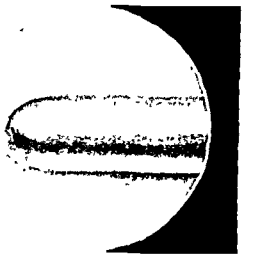
REBUTTAL TO THE OBJECTIONS OF DOCTORS CHRISTOPHER, KOCH AND OWEN. Jerome J. Weiner, M.D.
New York, N. Y. 157

MEMOIR

DOCTOR GATEWOOD Edwin M. Miller, M.D. 159

GREAT BRITAIN'S NEED OF SURGICAL SUPPLIES..... 160

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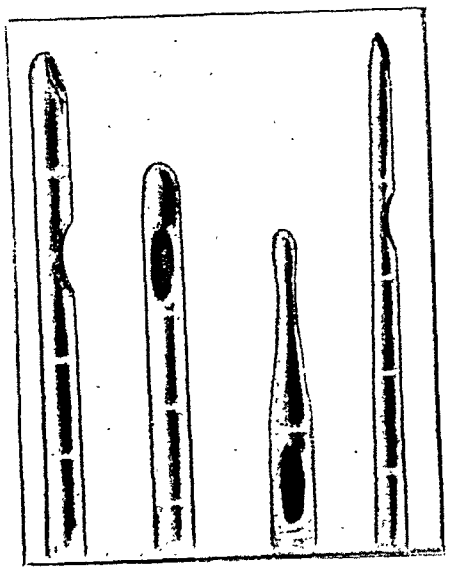
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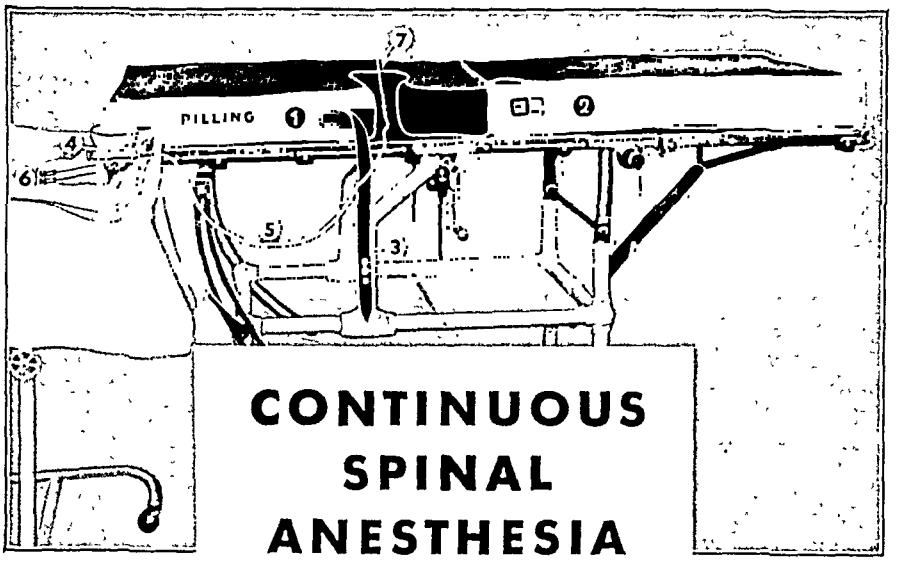
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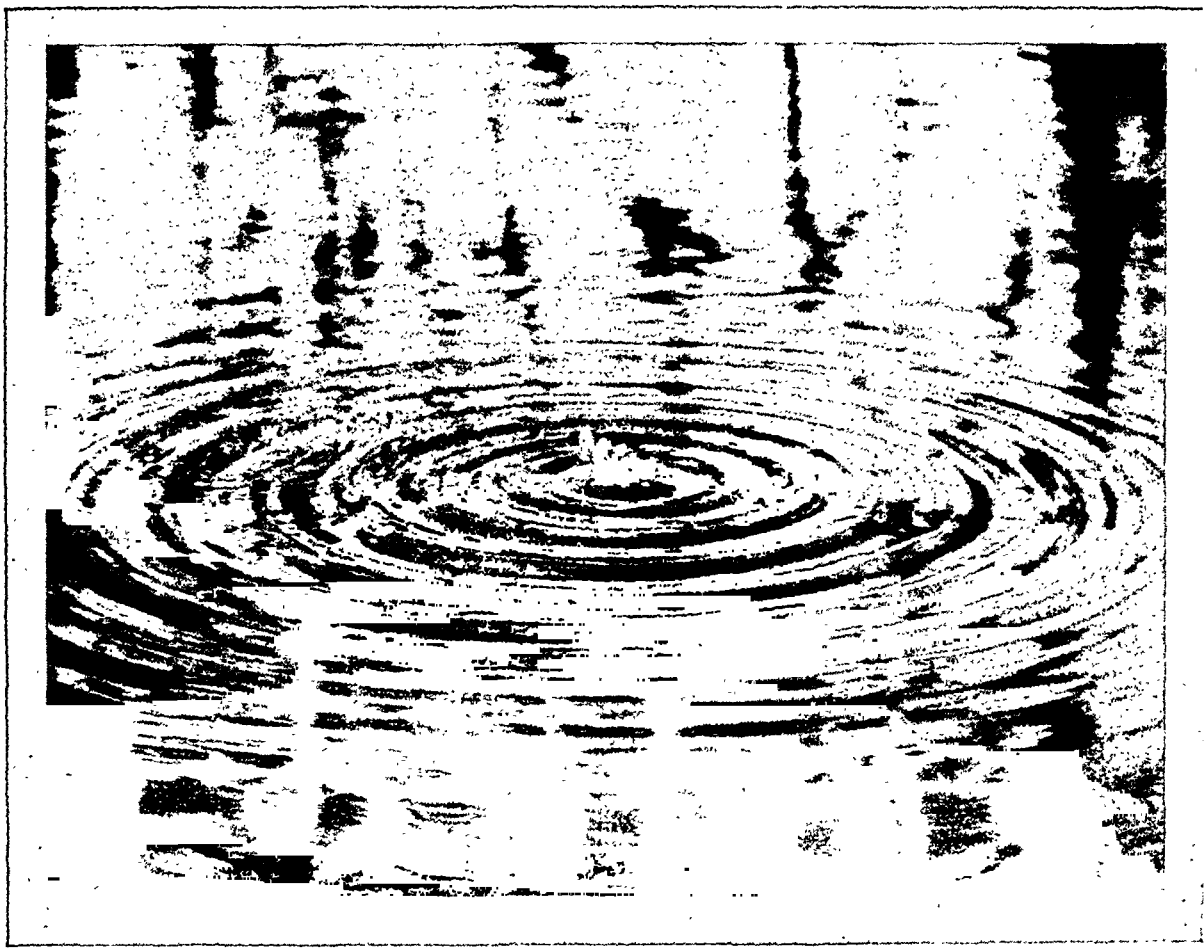
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INDEX TO ADVERTISERS

	Page
SURGICAL SUPPLIES	
American Cystoscope Makers, Inc.	5
Rudolph Beaver	23
Macalaster Bicknell Company	27
V. Mueller & Co.	21
George P. Pilling & Son Co.	6, 12
LIGATURES	
Davis & Geck, Inc.	Insert 8-9, 16
Gudebrod Bros. Silk Co.	26
C. De Witt Lukens Co.	16
Johnson & Johnson	15
PHARMACEUTICAL SUPPLIES	
Anglo-French Drug Co., Inc.	Inside Front Cover
Bilhuber-Knoll Corporation	21
Ciba Pharmaceutical Products, Inc.	Back Cover
Coca-Cola	18
Duke Laboratories, Inc.	18
Hoffmann-La Roche, Inc.	7
Eli Lilly and Company	13
Massillon Rubber Company	12
Merck & Co., Inc.	17
Purdue Frederick Company	23
Schering and Glatz, Inc.	10
Schering Corporation	Inside Back Cover
Frederick Stearns and Company	19
Upjohn Company	9
Winthrop Chemical Co., Inc.	8
PUBLISHERS	
Lea & Febiger	22
J. B. Lippincott Company	18, 20, 25, 26, 28
C. V. Mosby Company	24
HOTEL	
Chalfonte-Haddon Hall	25
X-RAY APPARATUS AND SUPPLIES	
General Electric X-ray Corporation	11
Patterson Screen Co.	14
Radium Emanation Corporation	4
MISCELLANEOUS	
Wilmot Castle Co.	3



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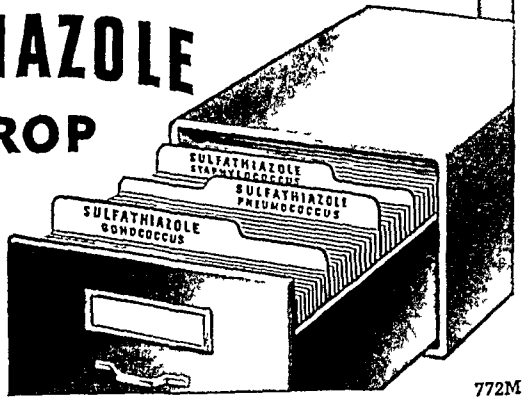
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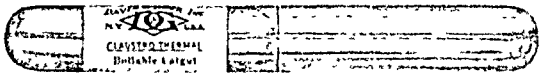
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963	Horsehair	2 x 28″	00
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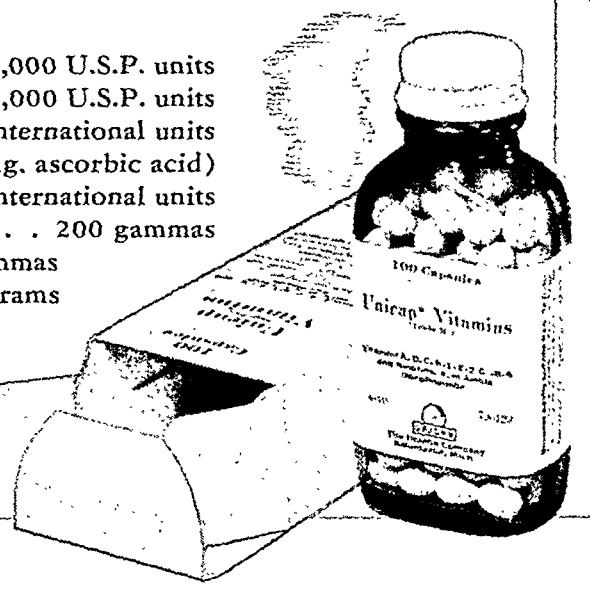
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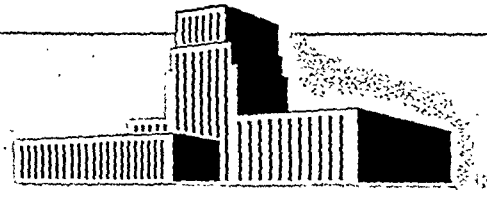
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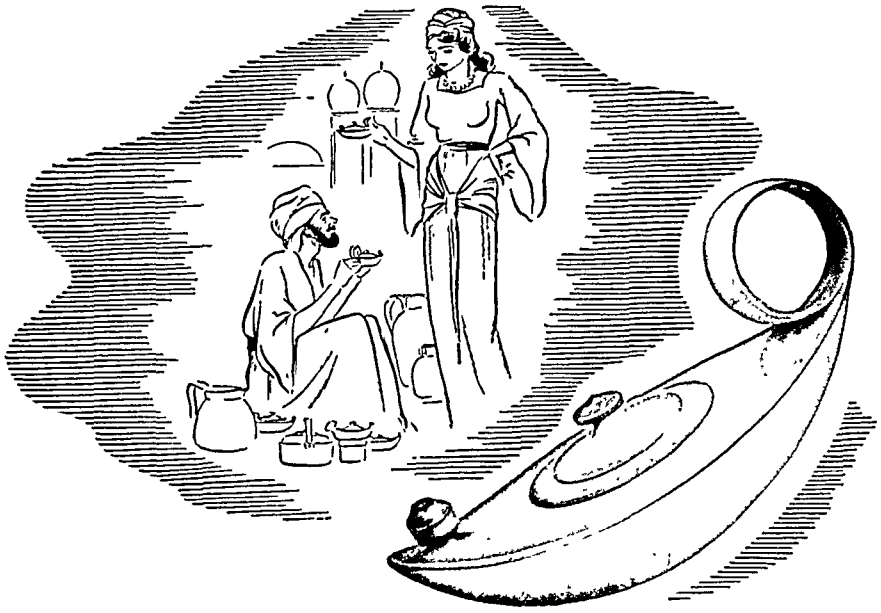
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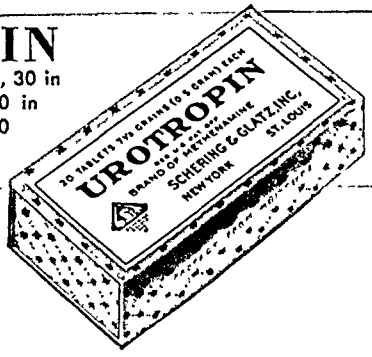
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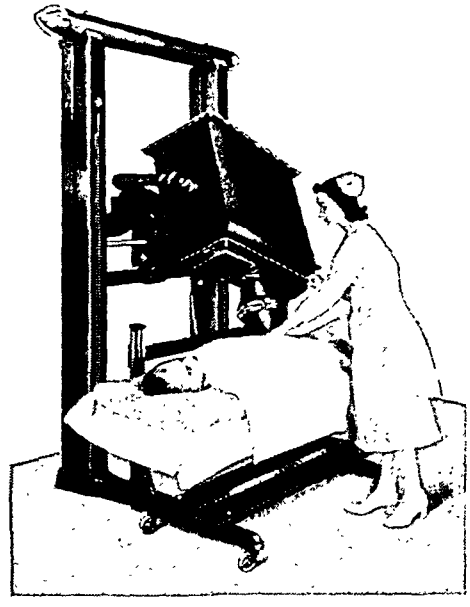


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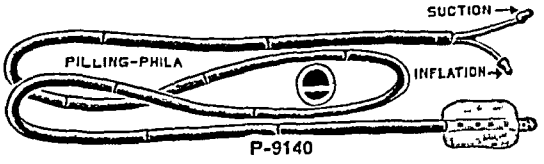
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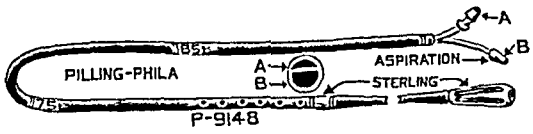
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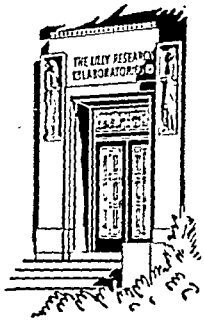
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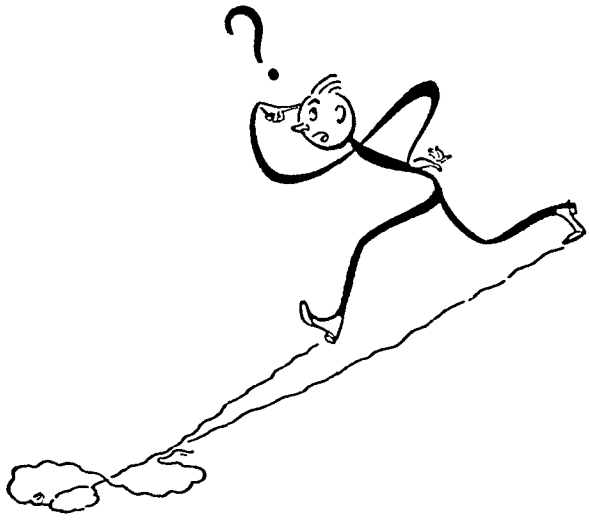
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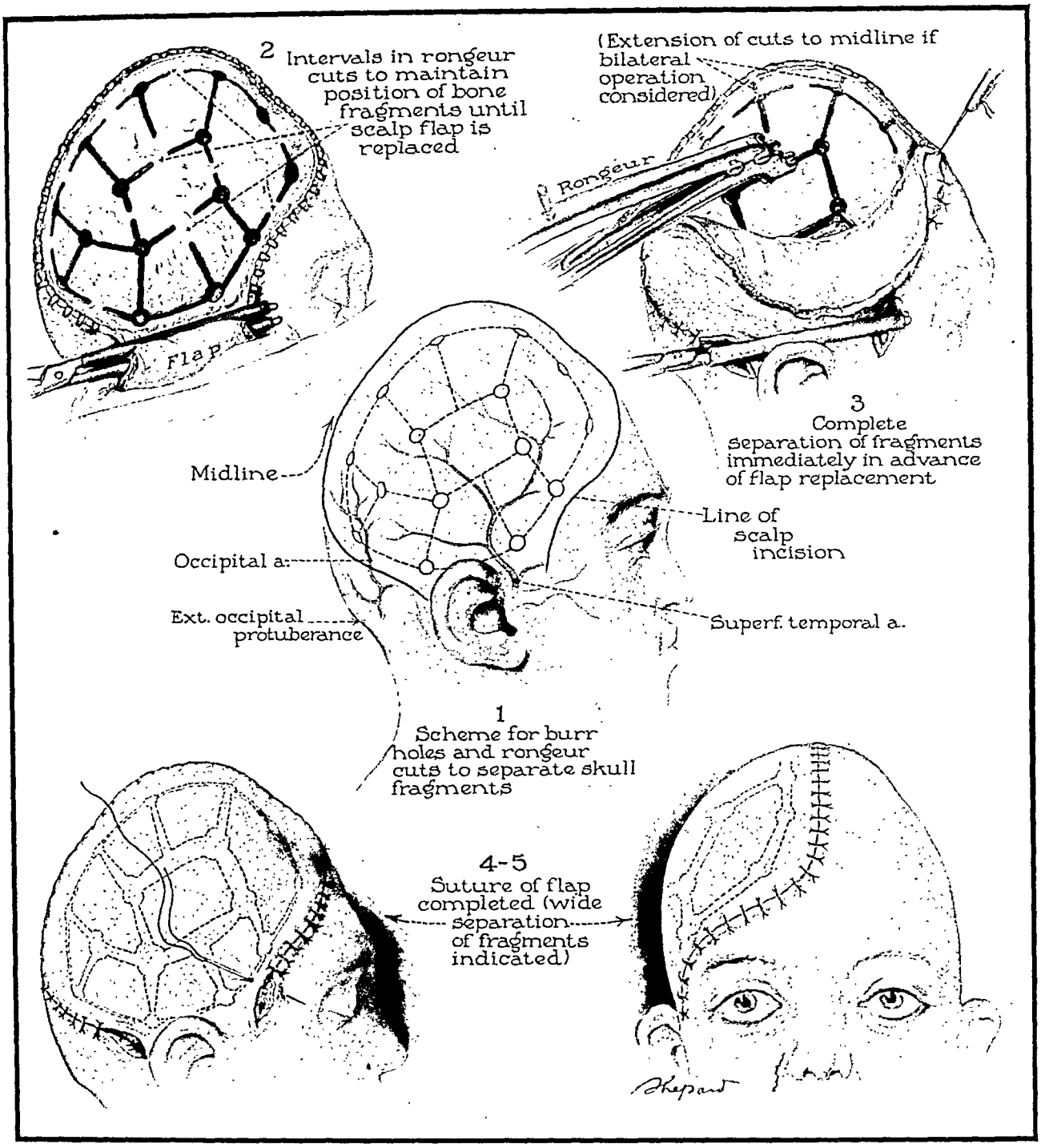
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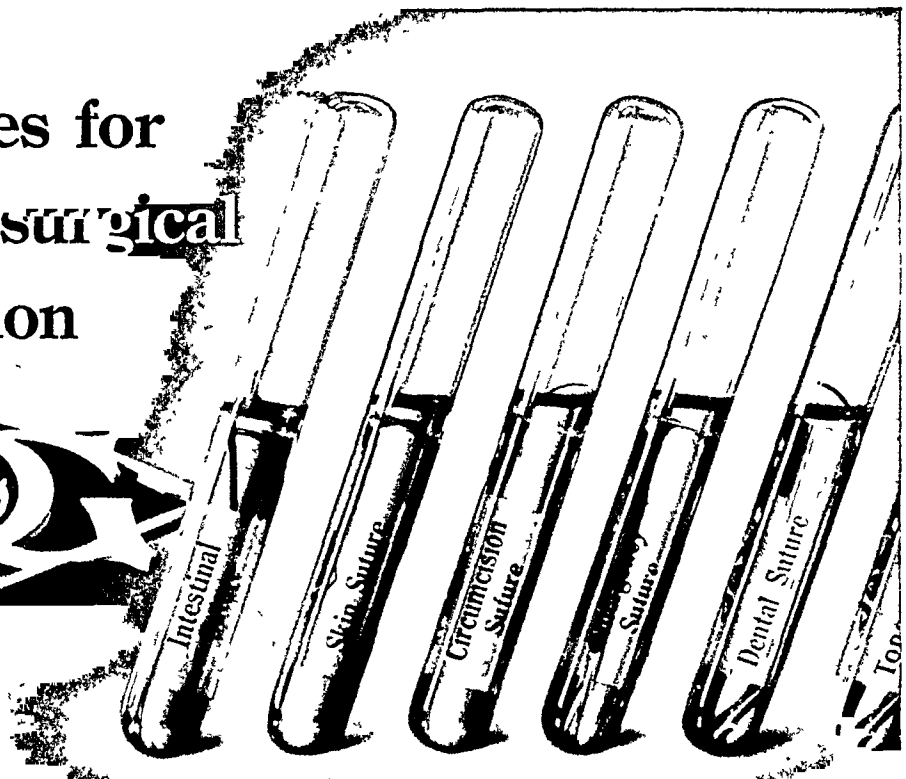
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ANNALS OF SURGERY

VOL. 113 JANUARY, 1941 No. 1

SYMPOSIUM

ON

INFLAMMATORY LESIONS OF THE COLON

PRESENTED BEFORE

THE NEW YORK SURGICAL SOCIETY

New York, N. Y. October 25, 1939

THE SURGICAL TREATMENT OF INTRACTABLE ULCERATIVE COLITIS

JOHN H. GARLOCK, M.D., New York, N. Y.

ACUTE DIVERTICULITIS AND SIGMOIDITIS

CARL EGGERS, M.D., New York, N Y.

LYMPHOGRANULOMA VENEREUM

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DISCUSSIONS BY

JOHN E. JENNINGS, M.D.
JOHN F. ERDMANN, M.D.
HENRY W. CAVE, M.D.
HENRY F. GRAHAM, M.D.

THE SURGICAL TREATMENT OF INTRACTABLE ULCERATIVE COLITIS*

JOHN H. GARLOCK, M.D.
NEW YORK, N. Y.
FROM THE SURGICAL SERVICE OF THE MOUNT SINAI HOSPITAL, NEW YORK, N. Y.

THE recent revival of interest in the surgical treatment of ulcerative colitis is evidence of the fact that, in a considerable percentage of the cases, conservative or medical therapy leaves much to be desired. There is general concurrence by all authorities that ulcerative colitis is primarily a medical disease and that the great majority of patients will respond sufficiently to conservative therapy to permit them to carry on in relative comfort. However, there remains a group, variously estimated at between 10 and 20 per cent, which resists every form of medical treatment and in whom the pathologic process in the colon progresses to irreparable involvement. It is with this group that this communication is concerned.

The management of ulcerative colitis is a cooperative problem and my associates and I have been most fortunate in having the advice and counsel of Drs. B. B. Crohn and Asher Winkelstein of the Gastro-Enterologic Department, as well as the entire Medical Staff. We have leaned heavily upon them from time to time and wish to acknowledge our indebtedness.

Time does not permit of an extended discussion of the symptomatology, pathologic features, and the many varieties of medical therapy. Suffice it to say that the disease, of unknown origin, is a progressive inflammatory condition of the colon which may be diffusely or segmentally involved. It is characterized by ulceration, infiltration of the colonic wall by the products of inflammation, and the formation of scar tissue. Polypoid degeneration of the mucosa is a not infrequent sequela. There are exacerbations and remissions with gradual progression of the pathologic process until the colon is converted into a greatly thickened, fibrotic, shortened tube, lined by infected granulation tissue constantly exuding pus and blood. The progress of the disease in the colon is reflected in the patient's general condition. Because of frequent rectal discharges with associated loss of fluids, and the general toxemia caused by absorption from the diseased bowel, gradual physical deterioration takes place with weight loss, anemia, avitaminosis and toxic manifestations such as fever, arthritis, skin infections, *etc.* When the colon has reached the stage of such involvement, the disease has become intractable, and it is useless to expect restoration to normal by conservative means.

The surgical treatment of ulcerative colitis, in the past, consisted of ap-

* Read before the New York Surgical Society, October 25, 1939. Submitted for publication October 7, 1939.

pendicostomy, cecostomy and, occasionally, colostomy. The purpose of these procedures was to permit of irrigation of the diseased bowel with medicated solutions in the hope of restoring the mucosa to normal. Experience, in recent years, has shown that this therapy was based upon fallacious reasoning. It is important to emphasize that the first requisite of successful surgical treatment is complete diversion of the fecal stream from the diseased bowel segment. This cannot be accomplished by appendicostomy, cecostomy or loop colostomy.

When the treatment of ulcerative colitis as a group problem was undertaken in this hospital in 1937, it soon became evident that it would be necessary to establish criteria for surgical therapy. We are now agreed that surgical treatment is indicated under the following conditions: (1) Uncontrollable hemorrhage. (2) Acute ulcerative colitis with profound toxemia. (3) Impending perforation. (4) Chronic colitis resisting all forms of medical therapy. (5) Segmental ulcerative colitis.

In group one are included cases of repeated large hemorrhages from the bowel, due to erosion of large vessels and resulting in a rapidly developing anemia. The mortality rate in this group, if untreated, is high. Complete diversion of the fecal stream by the performance of ileostomy will put the diseased bowel at rest and minimize the likelihood of further bleeding. We have had three such cases in our series and all recovered. Bleeding may continue for two or three days after ileostomy is performed, but it does not reach the serious proportions noted before operation.

The cases in group two constitute a difficult problem. The course of the disease is short and fulminating and the patients are desperately ill. A fatal outcome is not infrequent. From our experience to date, we are convinced that the *early* performance of ileostomy is a life-saving measure. Unfortunately, heretofore, ileostomy was deferred until the patients were practically moribund. Obviously, the death rate was very high and, as a result, the procedure came into disrepute. It is most important that ileostomy be performed at the opportune moment. In our series, we have had six such cases. One patient died after operation.

Whenever, during the clinical observation of a patient with ulcerative colitis, signs of threatened perforation of a colonic ulcer become evident, ileostomy should be performed as an emergency measure. Only by diminishing intracolonic pressure by diverting the fecal stream, can actual perforation be prevented. When perforation does take place, the mortality rate is close to 100 per cent. In our series, two patients presented symptoms strongly suggestive of imminent perforation and ileostomy was performed as an emergency measure. Both patients survived.

The fourth group comprises the intractable cases of chronic ulcerative colitis. With the aid of the barium enema and careful sigmoidoscopic examination, it is possible to accurately determine the extent and severity of the disease. It is upon these findings and the clinical course of the disease that the decision is made as to the plan of surgical attack. In most instances, a

preliminary ileostomy will be indicated. We have considered ileostomy as the first step of a graded multiple-stage operation involving subtotal resection of the colon. Every patient in our series of 25 cases has been treated according to this plan. However, in the cases presenting complete involvement of the colon and rectum, we have varied the procedure recommended by Cave, Cattell and others, insofar as we are not performing abdominoperineal removal of the rectum, but preserve that organ for possible future use in reestablishing intestinal continuity. The only contraindications to this plan are the presence of rectovaginal fistulae and polypoid degeneration of the rectal mucosa. This will be referred to later.

With the cases of segmental colitis, it may be possible to vary the plan of procedure already described. The type of operation selected will depend upon two factors: (1) The general condition of the patient; and (2) the site of involvement of the colon. When the left colon and rectum are involved, the performance of a transverse colostomy in preference to an ileostomy must be seriously considered. In such cases, complete transection of the colon and its *mesentery* and implantation of the colostomy stomata in separate incisions, after the manner of ileostomy, is obligatory. This is followed at a later date by removal of the diseased left colon. We are treating two patients in this manner. If the rectum is free of disease, an ileoproctostomy with transection of the ileum and also the colon proximal to the site of anastomosis may be the preliminary procedure of choice. Removal of the entire colon may be carried out at a later date. When the right colon alone is involved, the solution of the problem is a simple one. Ileosigmoidostomy with transection of the colon proximal to the anastomosis as advocated by Berg is the operation of choice. It is important to emphasize the fact that the colon must be transected above the site of every anastomosis in order to prevent progression of the disease to the uninvolved segment of bowel. This transection should include the mesentery. It is my impression, after observing the life history of this disease, that progression of the pathologic process takes place along the subserosal and mesenteric lymphatics as well as by the submucosa. Complete division of the bowel and its mesentery should obviate further extension.

Ileostomy.—There are a number of points concerning the operation of ileostomy which merit emphasis. There are so many objections to the old loop ileostomy that I believe this procedure should be discarded. A properly performed ileostomy should entail complete division of the ileum, the implantation of the proximal and distal stomata in separate incisions, and insurance against retraction of either stoma within the abdomen, and also external prolapse of the proximal stoma after it begins to function. About two and one-half years ago, we developed a new type of ileostomy which has satisfied all of these criteria. Recently, Cattell described a similar operation. Figures 1 and 2 indicate the essential steps. The abdomen is opened through a two-inch subumbilical, right rectus incision close to the midline. If the operating table is placed in Trendelenburg position, the loops of small bowel fall away toward the upper abdomen and the terminal ileum may be easily

visualized without handling and manipulation. I cannot emphasize too strongly the necessity of scrupulously avoiding any exploration or manipulation of the diseased colon at this time. In the acute cases, the wall of the bowel is very often of tissue paper thickness and the lightest touch of a sponge stick will result in perforation after a day or two. I am sure that many of the reported deaths after ileostomy may be attributed to ill-advised exploration of the colon.

A loop of terminal ileum is drawn out of the abdomen and its mesentery is divided about eight inches from the ileocecal junction. The vessels in the

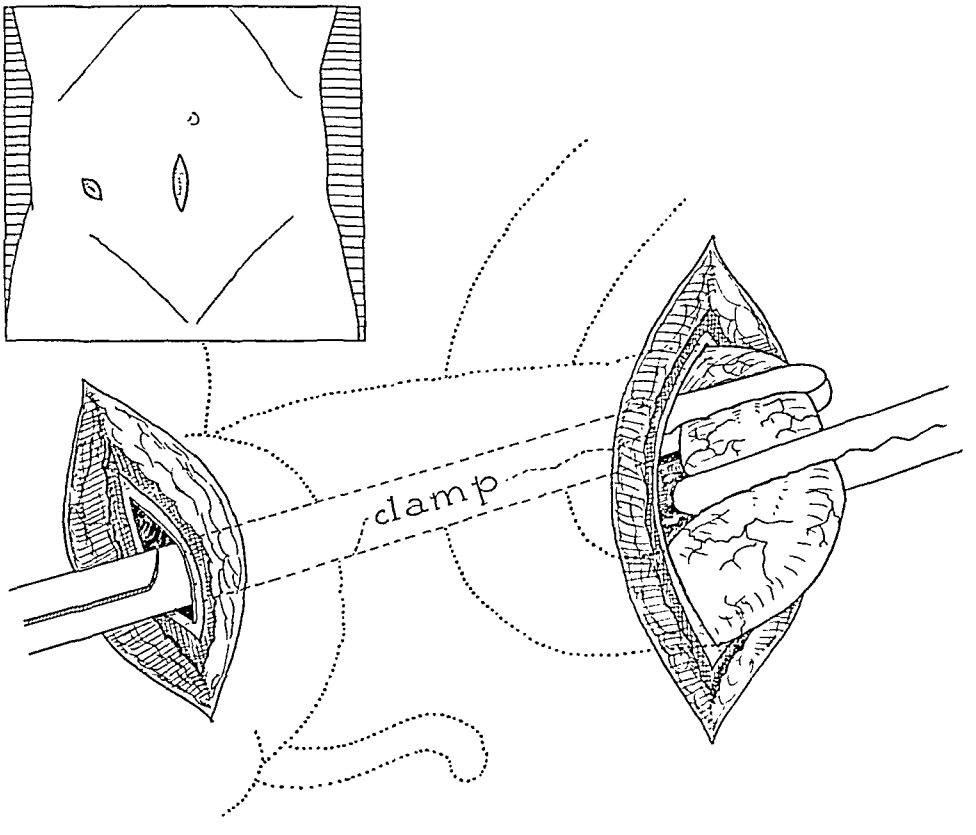


FIG. 1.—Operation for Ileostomy. The right rectus incision should be small and placed close to the midline. The proximal stoma is implanted in this incision, and the distal stoma is placed in the small McBurney incision.

distal two arcades are ligated, care being taken to insure adequate blood supply to the two ileal stomata. Through a one-inch right McBurney incision, a Payr clamp is inserted toward the rectus incision and is placed over the ileum. Another small crushing clamp is now applied to the ileum near the first one in such a way that the antimesenteric portion of bowel faces cephalad. The bowel is now divided between the clamps with the carbolic acid cautery. By proper elevation of the abdominal wall, the clamp protruding through the McBurney incision is withdrawn with the distal ileal loop. The bowel wall is sutured loosely to the fascia with a few fine chromic sutures and the wound is left open. The clamp remains in place until the fourth or fifth day. This forms the distal ileostomy stoma (Fig. 1).

The proximal loop is now drawn out at the upper angle of the rectus incision so as to project beyond the skin surface for three-quarters of an inch. As the peritoneum is repaired, the cut edge of the divided mesentery is included in each suture (Fig. 2). I believe this maneuver anchors the ileostomy in place and prevents the prolapse which was formerly a frequent disagreeable complication of ileostomy. We have not seen a single case of prolapse since we began employing this procedure. The bowel wall is sutured loosely to the neighboring fascia with vaselinized fine chromic catgut. The remainder of the rectus incision is closed in the usual manner. As a final step, a purse string suture of silk is placed in the bowel wall just below the blades of the

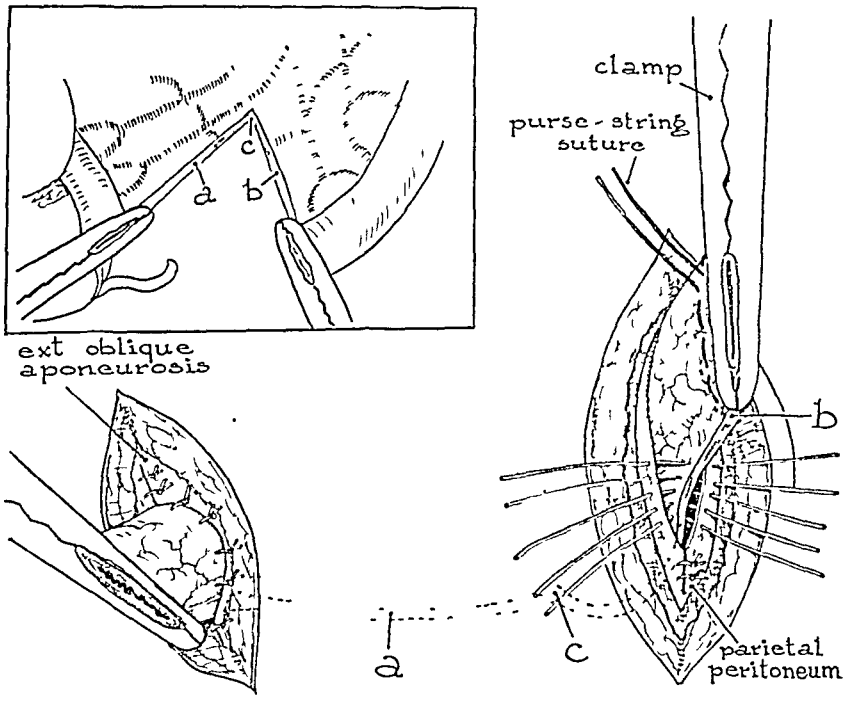


FIG. 2.—The insert shows the division of the mesentery of the terminal ileum. It will be noted that the proximal ileostomy is placed in the wound in such a manner that the antimesenteric border faces cephalad. As the peritoneum is repaired the cut edge of the mesentery is included in each suture. The bowel wall is anchored to the fascia with a few interrupted sutures. The distal stoma is located in the McBurney incision, and the bowel wall is likewise sutured to the fascia. The purse string suture beneath the clamp occluding the proximal stoma is indicated. This is utilized on the second day, when a large catheter is inserted into the bowel.

crushing clamp. The ends of the suture are tied and wound loosely about the bowel. The crushing clamp is removed in 24 to 36 hours and a large catheter is placed in the bowel and held in place by tying the silk purse string suture. On the fifth or sixth day, the catheter is removed and the ileal stoma is left open. With this technic, we have had only one superficial wound infection.

Our experience with 15 cases of ileostomy has crystallized a number of clinical facts which deserve emphasis:

(1) In the hemorrhage group, severe bleeding usually stops after ileos-

tomy. There may be a moderate hemorrhage or two during the first two or three days postoperative, but these are controlled by transfusions.

(2) In the acute, fulminating cases of colitis and the chronic cases with fever, ileostomy is usually followed by a dramatic change in the condition of the patient. The temperature drops rapidly to normal, often by crisis, and the numerous toxic manifestations abate.

(3) As time goes on, the rectal discharges decrease in amount and rarely contain blood.

(4) There is a gradual gain in weight. Most of the patients have gained between 20 and 40 pounds. This is accompanied by a sense of well-being which does much to raise the morale of these patients.

(5) We have not encountered a single instance of reactivation of the process in the colon or a return of acute toxic manifestations, once the colon has been excluded by ileostomy.

(6) The discharge from the ileostomy stoma is liquid in the beginning. In the course of a few months, coincident with gain in weight and improvement in the patient's general condition, the ileal contents gradually become semisolid. This change in the physical characteristics of the contents of the terminal ileum becomes even more pronounced after removal of the diseased colon. It would seem that a change takes place in the physiologic activity of the small bowel and that the ileum takes over the water-absorbing function of the diseased colon.

(7) There is always a certain amount of skin irritation surrounding the ileostomy stoma. It is usually more pronounced in the beginning. A considerable degree of local tissue resistance is developed as time goes on and, rarely, does this irritation bother the patient after three or four months. Most of the patients use a mixture of kaolin and aluminum paste to protect the skin. The discharges from the ileum are taken care of without soiling by a properly-fitting ileostomy bag.

(8) It is wise to defer resection of the colon until the maximum improvement has been obtained, usually six to 12 months.

(9) It is our opinion that ileostomy should, in no sense, be considered a curative operation. We have observed active disease still present in the colon 18 months after its exclusion by ileostomy. Reestablishment of continuity of the ileum is fraught with great danger. The literature contains a number of such instances in which a fatal issue followed the lighting up of a dormant process in the colon.

Further Operative Procedures.—Subtotal resection of the diseased colon should be carried out after the limit of improvement has been reached. If proctoscopic and sigmoidoscopic examination indicates a normal rectum and lower sigmoid, the first stage should consist of an anastomosis between the ileum and the anterior wall of the rectum. In the five patients, in whom ileoproctostomy was performed, the disease in the colon was found to terminate sharply just above the rectosigmoid junction. In each instance, the bowel was divided at this point, the distal end was inverted, the proximal

end was implanted in the upper angle of the left rectus wound to form a colostomy opening, and an isoperistaltic lateral anastomosis effected between the ileum, after disconnection of the ileostomy, and the anterior wall of the rectum. All healed by primary union without evidence of leakage. It should be emphasized that, when dealing with the bowel of an ulcerative colitis case, no blind ends be dropped into the abdomen, and that instead of inverting the end of the divided colon to be subsequently removed, the bowel end should be implanted in one angle of the incision as a colostomy opening. This will permit external drainage of discharges from the diseased segment. This important point has already been stressed by Berg. The next stage, carried out after two or three months, consists of removal of the sigmoid, descending, splenic flexure and left half of the transverse colon. The remaining colon end is again implanted in the wound. All raw surfaces are peritonized and the left retrocolic space is drained. The final stage consists of removal of the terminal ileal fistula and the remainder of the colon.

When the disease has involved the rectum as well as the remainder of the colon, our plan of attack has consisted of subtotal resection of the colon in two stages, starting on the left side, and leaving the lower sigmoid and rectum *in situ* for possible future use in reestablishing intestinal continuity. Whether the latter will be possible, time alone will tell. So far we have not carried it out. It has been our feeling that, unless the rectum is hopelessly diseased by pseudopolypoid degeneration or the presence of numerous fistulae, time, measured in terms of years, might eventually heal the lesion in the rectum and permit restoration of normal elimination. Our cases have not been followed long enough to warrant making definite statements relative to this, but in three instances, there has been marked improvement in the proctoscopic picture. Whether the rectal segment will be converted into a scarred tube, unsuitable for anastomotic purposes or develop strictures, we are unable to say. Continued observation will be of great interest.

At this stage, the upper half of the sigmoid, the descending colon and the left half of the transverse colon are mobilized and brought outside of the abdomen. The left retrocolic space is peritonized and the left rectus wound is closed about the two limbs of colon, the proximal limb being located at the upper angle of the incision and the distal limb at the lower angle. Only after the incision has been sutured, is the bowel divided between rubber-covered clamps and removed. This maneuver minimizes the possibility of wound contamination. The final stage, performed three to six months later, consists of excision of the remainder of the colon and the distal segment of ileum. In order to remove the field of operation from the ileostomy opening, we have used the upper abdominal transverse incision, cutting across both rectus muscles. If the patient is placed in Trendelenburg position, mobilization of the distal ileum and ascending colon is made easier. Before opening the abdomen, it is preferable to dissect the colostomy and ileostomy stomata from their respective scars and invert the bowel ends so as to avoid contamination. The right retrocolic area is drained through the right McBurney incision,

which marked the site of the distal ileostomy opening, and the transverse incision is closed snugly.

The patient now has two openings on the abdominal wall, one marking the ileostomy and the other, the colostomy leading into the distal sigmoid. The purulent discharge from the rectal segment gradually decreases in quantity and the patients show progressive improvement. Up to the present, we have not seen the need of excising the rectum in any of our cases. Whether this will prove to be the correct procedure, we are not prepared to say at this time. Prolonged observation of these patients will be necessary before this can be decided.

Results.—Our series consists of 25 patients treated surgically since September, 1937. In 15 cases, ileostomy was performed, with two deaths, a mortality rate in this group of 13.3 per cent. The first death occurred in the case of a male, age 21, with a one year's history of bloody diarrhea and recent onset of toxic symptoms with repeated hemorrhages. At operation, a sponge stick inadvertently touched the cecum. The patient died on the sixth day and, at autopsy, there were found two perforations of the cecum and one in the transverse colon with a diffuse peritonitis. The second patient, a female, age 18, presented symptoms of three months' duration. After ileostomy, there was satisfactory progress until the sixth day. She then began to deteriorate rapidly, presenting the picture of secondary anemia, hypoproteinemia, and peripheral edema. In spite of multiple transfusions, parenteral administration of vitamins and supportive therapy, death ensued on the eleventh day. At autopsy, there was found a necrotizing esophagitis and complete atelectasis of the left and of most of the right lung.

Of the remaining 13 cases, resection has been completed in eight patients according to the plan outlined in this paper. In two of these, ileoproctostomy was performed prior to removal of the diseased colon. There was one death in the resection group. This patient died of an avoidable accident, as at the final stage, it was found difficult to close the left end of the upper transverse incision and, accordingly, packing was inserted to wall-off the peritoneum. Premature removal of the packing permitted gross soiling of the peritoneal cavity by ileostomy contents and the patient died of diffuse peritonitis. This was demonstrated at autopsy. In four cases, resection of the left colon has been carried out and the patients are awaiting the final stage. The remaining patient has not as yet been subjected to further surgery since ileostomy was performed. All of these patients are doing well. There is minimal discharge from the remaining rectal segment and all have gained 20 to 30 pounds. The two patients with ileoproctostomy have one to three normal bowel movements a day and proctoscopic examination reveals normal rectal mucosa.

In the group of segmental ulcerative colitis, there were eight cases. In two of these, the disease involved the left colon and rectum, and transverse colostomy was performed with implantation of the proximal and distal stomata in separate incisions. Both patients have done well. There has been no evi-

dence of extension of the disease to the right colon. Resection of the diseased segment will be carried out shortly. Of the remaining six cases, three were subjected to primary ileoproctostomy followed by removal of the remainder of the colon in one or two stages. One patient recently developed a mild involvement of the rectal segment with hyperemia of the rectal mucosa demonstrable on proctoscopic examination. There has been a rapid response to medical therapy. The other two patients are in excellent health. In the remaining three cases, ileosigmoidostomy was performed as the first stage. In one patient, resection of the colon was completed, and she is well. In the second case, further surgery has not as yet been carried out. The third patient died after operation as a result of an error in judgment. This occurred in a male, age 36, who presented a rather acute history of five weeks' duration. The rectum and sigmoid were uninvolved, and ileosigmoidostomy was performed with division of the colon and its mesentery proximal to the anastomosis. The error was made of exploring the entire colon with the necessarily associated handling of the diseased bowel. The patient died two days after operation and, at autopsy, there was found a generalized peritonitis due to a perforation of the cecum. I believe that this perforation was traumatic in origin and occurred at the time of operation.

The final two cases of the series are classified as miscellaneous. One was a female, age 23, who presented a history of four years' duration. The clinical picture of diarrhea, loss of weight, rectovaginal fistula, moderate pyrexia, anemia and the roentgenographic evidence of involvement of the terminal ileum and ascending colon, suggested to the gastro-enterologists a diagnosis of ileitis with secondary colitis. Ileocolic resection was advised. At operation, the transverse and left colon appeared free of disease externally except for some thickening of the wall. Resection of the right colon was accordingly carried out. When anastomosis between ileum and transverse colon was attempted, extreme friability of the remaining bowel was demonstrated. Gross soiling occurred and the operation was terminated by establishing a double-barreled fistula composed of ileum and sigmoid. The patient died of peritonitis three days later. The operation was ill-advised and based upon an erroneous diagnosis. The second patient presented a long and complicated history. Briefly, her disease started in the terminal ileum in 1929, and the ileum was resected. A diffuse ulcerative colitis developed subsequently. The second operation consisted of an ileosigmoidostomy performed, apparently, in diseased colon. Then followed resection of the colon in two stages. When admitted to the service in December, 1938, she presented numerous abdominal fistulae and rather extensive ulceration of the rectum on proctoscopic examination. Operation was carried out and consisted of (1) resection of the ileosigmoidostomy anastomosis; (2) ileostomy; and (3) implantation of the upper rectal stoma in the abdominal wall. Since then, this patient has done very well. All the abdominal fistulae have closed and the rectal discharge has practically stopped. She has gained 35 pounds.

SUMMARY AND CONCLUSIONS

There were five deaths in this series of 25 patients, a gross mortality of 20 per cent. Analysis of the cases that died indicates that, in four instances, an error of technic or judgment was responsible for the mortality. It is fair to assume, with increasing experience in the surgical treatment of this disease, such errors will become less frequent, and that the mortality will reach well below 20 per cent. I believe that the surgical treatment of intractable ulcerative colitis will, eventually, be generally recognized as the only method at our disposal to-day of restoring these seriously handicapped patients to a relatively normal existence.

DISCUSSION.—DR. HENRY W. CAVE (New York) prefaced his remarks by paying tribute to the courage and the wisdom of Dr. Howard Lilienthal who, assisted by Dr. George Emerson Brewer, 40 years ago, in 1899, performed a colectomy upon a young woman, age 25, who was suffering from this disease in an aggravated form—she survived the operation, lived a normal life, gave birth to a child and died one and one-half years ago, at the age of 63, from a cardiac disease. An autopsy was performed and nothing unusual was to be noted in the abdomen except the absence of the entire colon, and a small rectosigmoidal pouch to which the ileum had been attached, which showed no evidence of disease.

Too long have surgeons followed blindly the idea that all people suffering from ulcerative colitis should be treated medically. It was hoped that Bargen's ideas on the specificity of a certain organism would result in the production of a vaccine which would be curative in most cases. But his contentions have not been substantiated by other investigators. Doctor Garlock states that there is a 10 to 20 per cent group that do not respond medically and should be treated surgically. Doctor Cave felt that as time goes on this group will be found to be much larger than is at present admitted.

Doctor Garlock also states that from time to time he has leaned heavily upon his medical associates; Doctor Cave suggested that he lean even more heavily and more constantly upon them for advice and counsel. This disease is commonly complicated by profound physiologic disturbances, changes in the plasma protein and electrolyte concentrations, inanition and marasmic states, advanced grades of vitamin deficiencies, disturbance of fluid balance and severe, refractory anemias, and is, therefore, better understood by the physician than by the surgeon.

The positive indications for immediate surgery are perforations, impending or actual; repeated massive hemorrhage; the frequently occurring and recurring perirectal abscesses; and those cases that are acutely ill and are apparently overwhelmed by a profound toxemia.

Diversion of the fecal current by transverse ileostomy is essential in a great majority of these patients. In a small group of less than 10 per cent low ileosigmoidostomy can be carried out as the first stage of the procedure. Ileostomy is accompanied by a high mortality rate due principally to the fact that surgical aid is solicited too late, and in many instances fatalities have occurred due to a rapid loss of fluids and chlorides. Doctor Cave cited three instances, in his experience, of alarming bleeding from the colon after ileostomy which was satisfactorily controlled by massive doses of vitamin K. In performing ileostomy the mucous fistula should be placed to the left of the midline so that at the second procedure, which is the more

difficult, due to the remoteness of the splenophrenic colic ligament, it is more easily divided through a long left paramedian incision. Instead of waiting 24 to 36 hours to remove the clamp and insert a large catheter in the ileal stoma, these patients had better have the ileostomy opened immediately following operation. Ileostomy should in no sense be considered a curative operation, but it is rather interesting in talking with various surgeons to hear them report definite cures following this procedure. Doctor William F. Nickel, Jr., of the New York Hospital, recently told Doctor Cave that he had collected seven authentic case reports where patients have remained well from nine to 17 years after ileostomy. In Doctor Cave's opinion cases in which ileostomy has proved to be curative are cases wherein a stage of intractability has not been reached.

With regard to patients with the chronic form of the disease with remissions, unanimity of opinion regarding surgical intervention is difficult to attain. In Doctor Cave's judgment, the patient should be given the benefit of a surgical procedure when the colon becomes transformed into a narrowed, shortened, fibrotic organ lined with infected granulation tissue; and the sooner this conclusion is arrived at the more hopeful is the ultimate outcome for that particular patient.

Doctor Cave disagreed with Doctor Garlock's statement that "in those cases presenting complete involvement of the colon and rectum" he does not perform "abdominoperineal removal of the rectum, but preserves that organ for possible future use in reestablishing intestinal continuity." This is predicated upon the concept that the diseased rectum which is shrunken, fibrotic and infected throughout its coats will return to a degree of normalcy that will safely permit of an anastomosis between it and the healthy ileum. It is hard to believe that this can come about and, if it cannot, it is a violation of a surgical principle to anastomose a healthy loop to another loop that still remains partially diseased. It is generally recognized that in 90 per cent of these cases the rectum is involved. In Doctor Cave's series there has probably been a higher percentage of involvement than in Doctor Garlock's. Cattell cites an incidence where this was attempted and the disease process spread from the rectum quite rapidly up the newly attached ileum and resulted in a fatality. Heuer has told Doctor Cave that he has already performed this operation on two individuals; both are improved but not well, one has developed perineal fistulae and Doctor Heuer plans to take down the anastomosis and remove the diseased rectum. Five of Doctor Garlock's patients were particularly fortunate in having had the disease process terminate so sharply just above the rectosigmoidal junction. With regard to Doctor Garlock's statement that he had not as yet carried out his plan to reestablish the fecal current from the ileum to the rectum that was involved, Doctor Cave felt that Doctor Garlock is perhaps too hopeful that the rectum will rehabilitate itself so that this proposed anastomosis would result in complete cure.

Doctor Cave agreed most heartily that no blind ends should be dropped back into the abdomen and that Doctor Garlock's method of mobilizing and bringing outside the descending colon and not removing it until his incision has been sutured is well worthy of comment and enthusiastic approval, for this maneuver certainly minimizes the possibility of infection. Although Doctor Cave has never employed the upper abdominal transverse incision, he felt that Doctor Garlock's intention of keeping away from the ileostomy opening by so doing is a good one. Doctor Cave said that, although up to the present Doctor Garlock has not seen the necessity of excising the rectum in any of his cases, with more experience he would probably find it necessary. On

account of perirectal abscesses, fistula-in-ano and an active process in the rectum Doctor Cave has had to remove the rectum in six individuals in his series.

In conclusion, Doctor Cave said that the mortality rate in his own series has been higher than that of Doctor Garlock's, there having been seven deaths in 31 patients operated upon, a mortality rate of 22.5 per cent.

DR. JOHN F. ERDMANN (New York) reported the following case of colectomy: The patient, H. S. M., aged 16, was admitted to the New York Post-Graduate Hospital on Doctor Gant's service, with a diagnosis of mucous colitis. An appendicostomy was performed by Doctor Gant. The patient was discharged November 22, 1915. A few weeks later, December 27, 1915, he was readmitted to Doctor Erdmann's service and an ileostomy was performed after the method of John Young Brown. He was again admitted March 27, 1916, with a diagnosis of chronic ulcerative colitis. Colectomy with ileosigmoidostomy was performed. The colon was resected, for ulcerative colitis, down to the midportion of the sigmoid and a lateral ileosigmoidostomy was effected June 3, 1916. The pathologist's report was "section from wall of intestine shows marked increase of adenoid tissue of mucous membrane with loss of the surface epithelium and relative decrease in the number of glands. There is considerable thickening of the submucosa due to increase of fibrous tissue and edema, and in it are some plasma and round cells."

During the patient's tour in the hospital, the hemoglobin varied from 65 to 40 per cent, with a low red count of 3,656,000. He was discharged July 6, 1916. On September 18, 1916, he was readmitted to the hospital for a discharge of blood, which frightened him. After various tests he was discharged September 21, 1916. His blood counts during 1916 were as follows: January 6: 4,160,000, Hb. 40 per cent; March 28: 3,064,000, Hb. 40 per cent; April 10: 4,600,000, Hb. 65 per cent; September 8: 4,848,000, Hb. 82 per cent.

The patient has been examined within the past four years. During the years between there had been no advance in the condition but rather a curative process. He presented all the appearances of a healthy, husky, strong man. It might be said that the patient had a few ulcerated spots in the rectosigmoidal zone, from which would be discharged a very small amount of blood at times.

DR. HENRY F. GRAHAM (Brooklyn) asked what "intractable" really means. In Mt. Sinai and Roosevelt hospitals, for instance, where special thought is given to these cases, it means one thing and elsewhere another. To illustrate the point Doctor Graham cited the case of a woman, at present in the Methodist Episcopal Hospital. She was transferred from another hospital where she was said to have had "intractable" ulcerative colitis for four and one-half years. She is anemic, but her nutrition was very good. When asked if her teeth had been examined roentgenologically, she said, "No." This was done and revealed two bad apical abscesses. Doctor Graham said he did not know, of course, that this patient's condition would be cured by removal of those teeth, but that he had seen patients with severe proctitis improve within two weeks after the removal of abscessed teeth, without an active recurrence. Poor medical treatment may make such cases "intractable."

Doctor Graham then cited a case to illustrate: First, the importance of early ileostomy; second, the importance of including the mesentery in the peritoneal suture to prevent prolapse; and third, the matter of the time interval between operations and the question of removal of the rectum. The patient was a boy, age 22, who developed a streptococcus sore throat in

April, 1937. Two or three months later he had a severe attack of diarrhea, during which he passed 30 to 40 bloody mucous stools daily. He lost 17 pounds during the first month of this illness. After one month in a hospital in New Jersey, he was admitted to the Methodist Episcopal Hospital in October, 1937. During the ensuing 19 days he lost an additional 10 pounds, which reduced his weight to 95 pounds. On November 7, 1937, an ileostomy was performed. Obstruction occurred from edema of the stoma and later a prolapse developed through the stoma. His weight increased to 144 pounds. On February 2, 1938, the cecum and colon were removed down to the sigmoid, for persistence of the colitis. The mesentery of the ileum was sutured to the peritoneum to prevent prolapse. His sigmoiditis and proctitis persisted, and 14 months later (April 19, 1939) the sigmoid and rectum were removed. The wound is now almost healed. Healing has been delayed because of long hours the patient spends driving a truck each day. He now weighs 155 pounds.

DR. JOHN H. GARLOCK (closing) said that he had not meant to imply that his medical confreres were consulted only occasionally with respect to the treatment of patients with ulcerative colitis. There has been constant cooperation and collaboration during every phase of this work, and, in most instances, the decision to operate has been made by the gastro-enterologist. The problem of conservation of the rectum is a very important one, but Doctor Garlock felt that most surgeons' experience is not large enough yet, nor has extended over a sufficiently long time, to warrant the statement that every case of diffuse ulcerative colitis requires an abdominoperineal resection of the rectum as part of the multiple-stage operative procedure. If the rectum is hopelessly involved in scar tissue, or presents extensive polypoid degeneration, then resection is indicated. On the other hand, in those cases presenting hyperemia and bleeding of the rectal mucosa on proctoscopic examination, it is not at all established that they should be subjected to removal of the rectum. The actual cause of the disease is unknown, and so is what the future holds with reference to determining that cause. Therefore, Doctor Garlock preserves the rectum in the hope of eventually utilizing it in a certain percentage of cases, to reestablish intestinal continuity. Only time, and a very large experience, will eventually decide this point.

ACUTE DIVERTICULITIS AND SIGMOIDITIS*

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THIS COMMUNICATION is based on 82 personally observed cases, in all of which the symptoms were sufficiently severe to warrant a surgical consultation. All patients were seen as primary cases, during the acute stage, except three, which had had a resection performed at another institution, and came to us with a colostomy. In one of these an acute attack of diverticulitis had developed in the segment of sigmoid remaining after resection of the originally involved portion, and required drainage. A second case was admitted with thoracic empyema and pyonephrosis, 18 years after a sigmoid resection. She is included simply as a late-result. The third case desired closure of her colostomy.

Many of the patients had a history of previous intestinal symptoms similar to those for which they were seen by us. The majority recovered under conservative management. Some were admitted as surgical emergencies and had to be operated upon at once. Others were operated upon for the relief of symptoms or to rule out malignancy. All patients have been kept under observation. Many have had no subsequent serious symptoms, while others have been seen several times with recurrent attacks.

The majority belonged to the somewhat better situated class as indicated by the fact that 65 were private cases and only 17 were ward cases. No conclusions, however, can be drawn from this, because there was nothing exceptional in their mode of living or habits which seemed to have a bearing on the etiology, except perhaps constipation. Adiposity does not seem to be a factor.

Our reason for presenting these cases is to call attention to the frequency of the condition and especially to the serious complications which may be associated with it and which require prompt surgical attention.

Age and Sex Distribution.—The disease was most frequently encountered in the age-group between 50 and 60 years. Thirty-one, or 37.9 per cent, occurred during this period. The others are distributed as indicated in Table I. There were 41 women and 41 men in the group.

TABLE I

AGE DISTRIBUTION OF 82 CASES

	30–40	40–50	50–60	60–70	70–80	80–90
Number of Cases.....	6	13	31	20	10	2

Symptoms and Physical Signs.—In order of frequency, the following symptoms and physical signs were noted (Table II):

* Read before the New York Surgical Society, New York, N. Y., October 25, 1939. Submitted for publication October 7, 1939.

TABLE II

FREQUENCY OF OCCURRENCE OF SYMPTOMS AND PHYSICAL SIGNS

Symptoms	Number of Cases	Per Cent	Symptoms	Number of Cases	Per Cent
(1) Pain	82	100.0	(8) Gas	21	25.6
(2) Fever	56	68.3	(9) Perforation	20	24.4
(3) Constipation	56	68.3	(10) Vomiting	19	23.2
(4) Palpable tumor	37	45.2	(11) Urinary symptoms	16	19.5
(5) Leukocytosis	34	41.5	(12) Bleeding	16	19.5
(6) Cramps	28	34.2	(13) Loss of weight	15	18.3
(7) Obstruction	24	29.3	(14) Diarrhea	15	18.3
			(15) Associated carcinoma	5	6.1

Diagnosis.—(A) Uncomplicated Cases: The most important point in reaching a diagnosis is to bear the condition in mind when patients with suggestive symptoms present themselves. Lower abdominal pain, with cramps, gas, fever, and perhaps alternating constipation and diarrhea, should cause one to think of a sigmoid lesion. Tuberculosis, syphilis, polypi, simple ulcerations or endometrial implants have to be considered. Pelvic disease, which may simulate the symptoms of diverticulitis, should not present a serious diagnostic problem. The two important lesions which come under consideration are carcinoma and diverticulitis. In order to make a correct differential diagnosis, it is necessary to properly evaluate symptoms, to utilize all physical signs and to have good roentgenologic examinations. It is usually not one symptom or sign but a combination of several which makes a positive diagnosis possible.

A prolonged history of disability, with progressive symptoms of constipation, cramps, blood in the stool, a palpable tumor and perhaps loss of weight, favor the diagnosis of carcinoma. On the other hand, if the symptoms are of short duration, if pain is an outstanding symptom, and if there is fever and leukocytosis, a history of former attacks, and examination shows tenderness and rigidity, the diagnosis of diverticulitis is more likely.

Neither condition is an emergency, and one may follow conservatism until a definite diagnosis is possible. The age of the patient is of no diagnostic value because both conditions affect the same age-groups. The course of the disease, on the other hand, may aid a great deal. With bed rest, fluid diet, hot or cold applications, and careful low rectal irrigations, the acute signs may quickly disappear, and permit careful physical examination.

There are, of course, patients in whom the symptoms are much more severe. They may be acutely ill with pain, fever and obstructive symptoms. There may be doubt whether local perforation has taken place. At times, urinary symptoms predominate. Good judgment is required in directing treatment. All colonic instillations must be avoided until acute symptoms and signs have subsided.

Digital rectal examination can do no harm. Proctoscopic examination, on the other hand, is not indicated. The greatest aid in the differential diagnosis

is a roentgenologic examination after the administration of a barium clysma. It is important not to use force for fear of causing a perforation. The following procedure should be followed: (1) Flat film. (2) Fluoroscopy—watching the barium mixture flow in, with only slight manipulation. (3) Take roentgenograms in different positions, including oblique and lateral. (4) Take subsequent roentgenograms after six and 24 hours. (5) If sufficient information is not obtained, careful air inflation may be of value.

Stewart[1] has compiled a tabulation on the differential diagnosis between

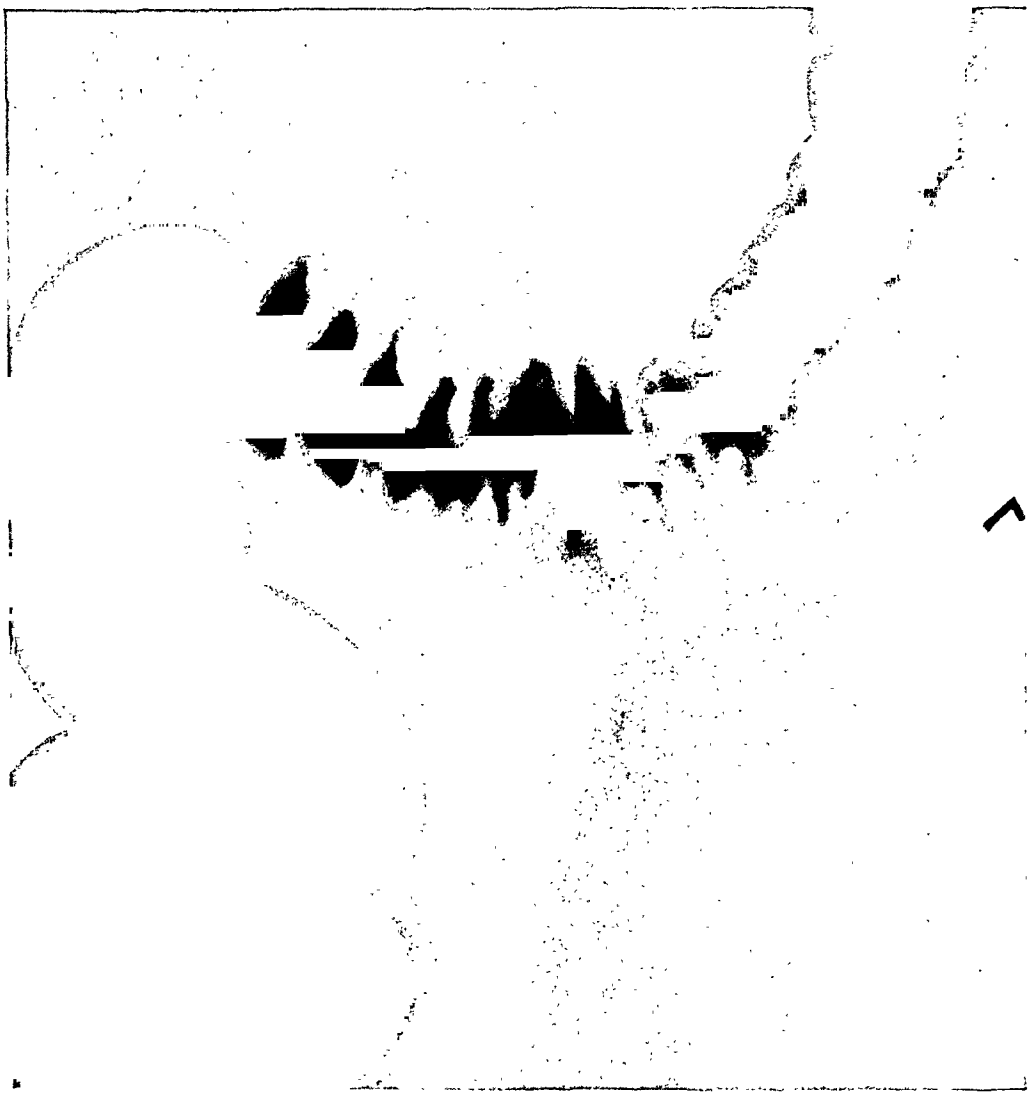


FIG. 1.—Typical serrated appearance of acute sigmoiditis.

carcinoma and diverticulitis which is very helpful. Not all the differential points mentioned by him can be elicited in any one case. The important and common differences between the two conditions are as follows: In diverticulitis, there is involvement of a long segment with its lumen narrowed and presenting a serrated appearance. It shows spasm, perhaps one or several diverticula close to the lesion, and is tender to touch (Fig. 1). In carcinoma the haustral markings are destroyed and there is either a napkin-ring or mas-

sive deformity with crater formation (Fig. 2). Notwithstanding such careful study, however, a positive diagnosis cannot be made in some cases, and serious doubt remains. In some patients a short period of observation will aid, while in others an exploratory celiotomy is indicated. Even then, it is not always



FIG 2.—Carcinoma of sigmoid associated with acute sigmoiditis

possible to make a positive diagnosis and resection has to be resorted to (Figs. 3 and 5).

The relative frequency of the two conditions may be judged on the basis of gastro-intestinal roentgenologic studies, made at our hospital, during the course of one year (Table III):

TABLE III

INCIDENCE OF DIVERTICULITIS, DIVERTICULOSIS, AND CARCINOMA

(*Lenox Hill Hospital, November* 1, 1938–*October* 31, 1939)

Gastro-intestinal series (total)	902	
Terminated at 6 hrs	255	
Carried through 24-hr. period	647	
Diverticulosis diagnosed in	49	or 7.5%
Barium enemata	428	
Diverticulosis diagnosed in	58	or 13.5%
Diverticulitis associated with diverticulosis	18	or 31.0%
Carcinoma of sigmoid	31	or 7.2%

(*B*) *Complicated Cases with Perforation.*—The clinical picture is quite different when diverticulitis is complicated by perforation. When first seen,



FIG. 3.—Acute sigmoiditis. Resected because suspicious of carcinoma. (Also see Fig. 5.) Same patient.

the patient may have a spreading peritonitis, the origin of which is doubtful. The onset, with acute pain on the left side, and a history of previous attacks of pain on that side, may help one. In case there is an abscess, it is most likely on the left side and, therefore, easy of diagnosis. When situated in the pelvis or lower midabdomen, a positive diagnosis may not be possible until after opening the abdomen. If the abscess is small, localized in the mesentery, or plastered against the sigmoid or the pelvic wall, the symptoms

and signs are relatively mild and permit study and observation. A late diagnosis may be reached the same as in uncomplicated cases (Fig. 4). In all other patients, we are dealing with acute surgical emergencies requiring prompt attention. The indication is to operate and to make a diagnosis after



FIG 4.—Ruptured diverticulum of sigmoid which could be lifted out with the inflammatory mass. Resection was performed

incision; and then to handle the problem presenting itself according to one's best judgment.

(C) *Diverticulitis Resulting in Intestinal Obstruction.*—When a patient is seen with symptoms of intestinal obstruction, the differential diagnosis between diverticulitis and carcinoma is very difficult and may be impossible (Figs. 2, 3 and 5).

The pain associated with acute diverticulitis is usually more severe, apparently due to muscle spasm of the intestine. The patient may be covered with perspiration and appear shocked. The presence of temperature and leukocytosis may be of aid. There may be a history of former attacks.

In obstruction due to carcinoma of the sigmoid, there is usually a history of continuous and slowly increasing disability. A tumor may be palpable, without much tenderness or rigidity. Blood may have been noticed in the



FIG. 5.—Acute sigmoiditis with multiple diverticula. Note thickness of inflamed wall. Resected because of suspicion of carcinoma. (Refer to the roentgenograms of the same case, Fig. 3.)

stool. There may be dilation of the cecum. Temperature and leukocytosis are absent unless a complication is present.

If the obstruction is acute, and apparently complete, prompt operation is indicated. It should usually be of a palliative nature and be limited to a cecostomy, colostomy or a first-stage Mikulicz procedure. A differential

diagnosis may be possible after the acute symptoms have subsided, and will influence the subsequent treatment.

In incomplete obstruction there is usually time for observation and diagnostic examinations, the same as in uncomplicated cases. If pain or tumor persists, or there is a suspicion of carcinoma, an exploratory operation is indicated. It does not always clarify the situation, and resection may have to be resorted to as a safety measure.

Treatment.—Of the 82 cases reported, 46, or 56 per cent, were uncomplicated. Patients with normal or very slight temperature were treated ambulatorily. They were put on a light diet, with little residue, and mineral oil was ordered for morning and evening. Rectal irrigations were given when indicated, and either a hot-water or an ice-bag applied during the resting periods.

All the more acute cases were put to bed. Aside from fluid diet, and perhaps a little mineral oil, nothing was ordered until a probable diagnosis could be made. A blood count was done. As soon as it was considered safe, a careful rectal irrigation was given. This was followed by roentgenologic examination, rarely after a barium meal, but usually after a barium clysma, which must be given carefully to avoid perforation. In one case severe pain followed a barium clysma given at a roentgenologist's office. The patient developed an abscess which was neglected and resulted fatally. With rest, perhaps the application of an ice-bag or heat, and with careful rectal irrigations, the acute symptoms usually subside in a few days and the patients become ambulatory. It is interesting to observe how quickly a large mass may disappear. In case there is unusual delay, the reason has to be looked for. In a few cases roentgenotherapy was apparently of value in aiding dissolution of the mass.

After the acute symptoms had subsided, patients were instructed in the pathology underlying their complaints. They were also made familiar with the measures calculated to avoid recurrence—such as the use of mineral oil to insure daily evacuation, restriction of food with a large residue, and avoidance of overeating. That these measures apparently have some success is evidenced by the fact that most patients have remained free from recurrence. On the other hand, several recurrences have shown that there is no positive safeguard in avoiding acute inflammation in those patients afflicted with diverticulosis. The condition must be considered a serious one, and one must be prepared at any time to see a recurrence or a complication requiring surgical intervention. In spite of definite instruction, two patients failed to apply for treatment promptly on the return of symptoms and were finally admitted with a neglected abscess to which they succumbed.

Surgical Treatment.—In the remaining 36, or 44 per cent, some type of surgical intervention was indicated or became imperative. In two of these, operation was not carried out. One of them was a patient with an associated carcinoma, who refused operation. The other one had general peritonitis

with multiple abscesses; she was admitted practically moribund and died within 24 hours.

This leaves 34, or 41.5 per cent, of the 82 cases in whom some type of operation was performed. Surgical treatment was always undertaken for a definite indication, either for perforation with abscess or peritonitis; for obstruction; for persistent pain; for recurrent attacks; or on the suspicion that carcinoma might be associated with the condition.

The procedures detailed in Table IV were carried out:

TABLE IV

OPERATIVE PROCEDURES

Total Cases Operated Upon 34, or 41.5%

Exploratory operation	3
Exploratory operation with separation of adhesions	4
Colostomy	6
Cecostomy	2
Resection	8
6 for inflammatory mass	
2 for carcinoma	

Acute Perforations 19, or 23.2%

With abscess	7
With peritonitis	12

Procedures Carried Out in This Group

Drainage only	14
Drainage and appendicectomy	3
Drainage and resection	1
Drainage and colostomy	1

The most serious cases were those with acute perforation. Some presented very complicated pictures with peritonitis; pus pockets; adhesions; obstruction; *etc.* In one case, an associated carcinoma had perforated. Loops of small intestines were adherent to the mass in some cases and produced obstruction by angulation. In one case there was thrombosis of the vessels with gangrene of the sigmoid.

Of the 12 cases of peritonitis that were operated upon, only four recovered completely. Six died at the hospital and two others recovered temporarily and died long after of complications or sequelae. One of these had an associated carcinoma.

Of the seven perforations who developed an abscess, five recovered and two died. In one of these neglected cases the abscess dissected retroperitoneally in spite of drainage and pointed in the opposite groin.

In the 15 cases operated upon for obstruction, persistent symptoms or tumor, or because of the suspicion of malignancy, the same rules which guide surgeons in colon surgery for other conditions were applied. In several cases a stage-operation, with preliminary cecostomy or colostomy, was performed.

The simplest operation was an exploratory celiotomy in three cases, and

combined with separation of adhesions in four others. The operations were undertaken for the relief of symptoms or to rule out carcinoma. In three of these patients, the tumor mass was lifted out of its bed where it had become adherent and produced incomplete obstruction, and placed into a more favorable location.

A cecostomy was performed on two cases for the relief of obstruction. In one case, it was closed after the acute symptoms subsided. In the other case, it was left permanently as a safety valve.

A colostomy was performed in two cases for the same reason. One case had an inoperable carcinoma associated with diverticulitis, while the other had complications which eventually led to a fatal outcome. Of the other four colostomies, three remained permanently, after resection of an inflammatory tumor. In only one case was it possible to close it later. This is due to the fact that the involved segment, which requires resection, is so long, that the ends of the remaining intestine cannot be approximated. The lower stump is simply closed and allowed to drop back. A combined abdominoperineal resection is not required in benign lesions.

Of the eight resections, two were performed for carcinoma—two for a painful, recurrent mass with inflammation or suppuration in the wall; and four, because the lesion was suspicious of carcinoma. All recovered from the operation. The carcinoma cases have since died, but the benign cases remained well.

Results.—The total, immediate mortality in the 34 cases operated upon was eight, or 23.5 per cent—restricted entirely to the acute perforations. There were, in addition, two late deaths from complications and four deaths due to carcinoma. One case died of carcinoma and one of peritonitis without operation. This makes a mortality rate of 19.5 per cent, or 16 mortalities out of the total 82 cases, which may be attributed directly to diverticulitis or one of its complications or associated conditions. By excluding the five carcinoma cases, the death rate is 13.4 per cent, or 11 mortalities with or without operation.

TABLE V

SUMMARY OF RESULTS

Total No. of Cases	82
Uncomplicated cases treated conservatively	48
Died as result of the disease	2
1 peritonitis	
1 carcinoma	
Complicated cases operated upon	34
Early deaths from perforation	8
Late deaths from complications	2
Died of carcinoma	4

Of the 20 operated cases who recovered, two have since died of intercurrent disease, 18 and 25 years after operation. This leaves 18 cases living at the present time. Fifteen are entirely well; one has a ventral hernia; one has



FIG. 6.—Diverticulum of sigmoid buried in wall. Does not project beyond serosa.



FIG. 7.—Complete diverticulum of the sigmoid projecting beyond the serosa.

a colostomy; and one has a fistula, which is of recent origin and will probably close shortly.

Pathology of Acute Sigmoiditis.—The mass seen and felt at operation, during an acute attack of diverticulitis, is a red, hard, nodular tumor. The appearance is due to thickening of the wall, involvement of the appendices epiploicae and diverticula, as well as adhesions. The serosa is rough and granular and frequently there is fibrin deposit and perhaps a small encapsulated abscess in the wall. This appearance usually permits dif-

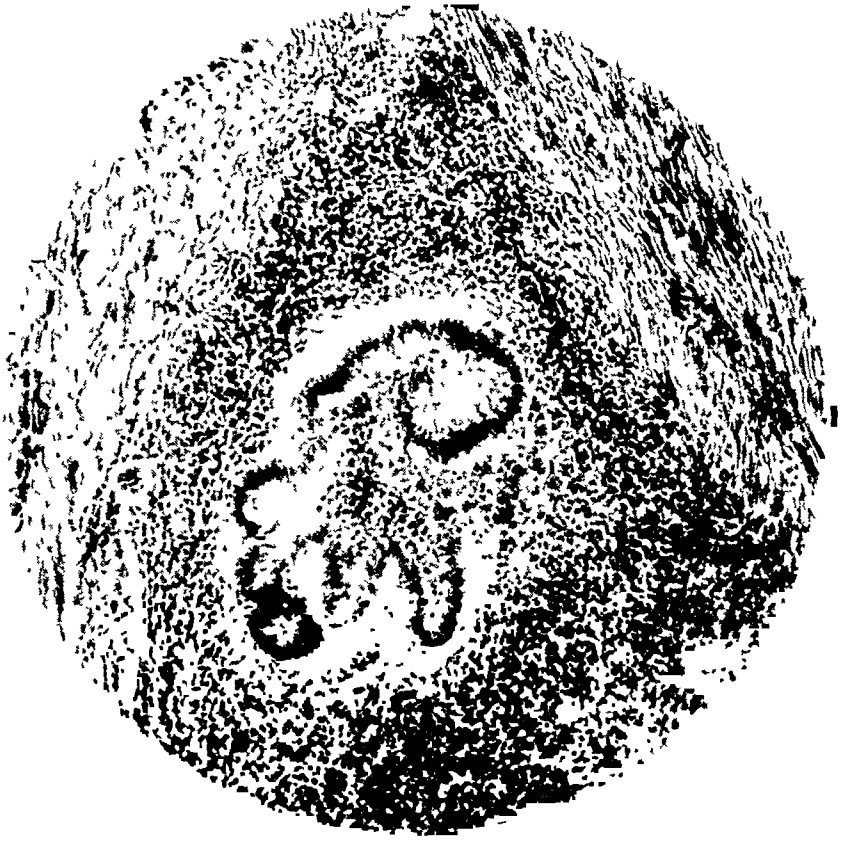


FIG 8.—Diverticulum of sigmoid surrounded by round cell infiltration

ferentiation between an inflammatory mass and carcinoma. If peritonitis is present, indicating that perforation has most likely taken place, careful search frequently fails to reveal any opening. One may assume that it was of pinhole-size only and has become closed off with a fibrin plug, or that bacteria have passed through the wall and involved the peritoneum. Whether to resect or not under these circumstances is a question of judgment.

Without gross perforation or exudate, perhaps, in a case diagnosed as appendicitis or sigmoiditis, we have simply removed the appendix and closed the abdomen. If exudate was present, we have drained. In several cases in which the tumor mass had dropped into the pelvis, angulated the sigmoid, and had loops of small intestine adherent to it, we have freed the adhesions,

lifted the tumor out of its bed and placed it into a more favorable position. The results have been very satisfactory.

In case a gross perforation is present, the involved intestine should be exteriorized by a Mickulicz procedure, if that is possible, and later resected. If that is not possible, because of fixation or length of involved segment, ample drainage and a colostomy above the lesion is the procedure of choice. If the exudate due to perforation has been walled off to form an abscess, early and adequate drainage is essential because of the danger of rapidly spreading putrid infection.

In case resection is performed, and the specimen is opened, it is surprising how little actual obstruction exists. The mucosa is either normal or it shows



FIG. 9.—Cross-section of colon. The larger lumen is that of the intestine. Above it is an acute abscess (in a diverticulum), the walls of which are partially lined by intestinal mucosa. The remaining portions of the mucosa have been destroyed by the suppurative process.

redness and superficial erosions, but no ulceration. It is at once evident that the lesion does not arise in the mucous membrane as in carcinoma, but is confined to the wall and perisigmoid tissues. Openings of one or several diverticula may be visible and pressure on the thickened wall will cause exudation of secretion or expulsion of small hard fecoliths which had been impacted in the diverticula (Fig. 5).

Studying the thick edematous wall of such a resected specimen frequently reveals no definite diverticula visible externally. They may be in an early stage of development, still confined within the wall as shown in Figure 6. Even in this state however, they may become inflamed and, by perforation into the wall, produce a phlegmon which, in turn, produces the tumor mass. An inflamed, fully developed diverticulum is more likely to perforate externally and give rise to peritonitis (Fig. 7).

Microscopic study of resected specimens shows diverticulitis or sigmoiditis, with small round cell infiltration surrounding the diverticula (Fig. 8), or an acute suppurative process (Fig. 9). In five of our cases there was an asso-

ciated carcinoma. Whether this condition is an independent lesion or whether it is the result of irritation produced by the diverticulitis, is left to conjecture.

SUMMARY

(1) A group of 82, personally observed, cases of acute sigmoiditis and diverticulitis is reported.

(2) The majority of cases recover with conservative treatment and they may guard against recurrence by regulation of diet and bowel habits.

(3) In this series of carefully followed cases, 36 patients, or 43.9 per cent, developed a condition which seriously threatened their lives.

(4) Twenty of these, or 24.4 per cent of the total, developed acute perforation with abscess formation or peritonitis. In 14, a simple drainage operation was performed; in five others drainage plus some other procedure, and one was not operated upon. There was a mortality of nine early deaths, or 45 per cent. There was one late death from complications—making a total mortality of ten cases, or 50 per cent directly due to perforation.

(5) Twenty-three other operations were performed, either an exploratory celiotomy, exploratory with separation of adhesions, colostomy, cecostomy, or resection. There was no mortality in this group.

(6) There were five patients with an associated carcinoma, all of whom eventually succumbed to the condition.

(7) The total mortality, directly traceable to the sigmoid lesion, was 16, or 19.5 per cent.

(8) The pathology is described.

(9) This group-study of acute sigmoiditis and diverticulitis calls attention to the seriousness of the condition. It reveals that diverticulosis, as such, is not an innocuous lesion. Once recognized in a patient, the physician or surgeon assumes a serious responsibility if he allows the patient to depart without warning him of possible danger and instructing him in the known means at our command to avoid complications.

REFERENCES

[1] Stewart, William H., and Illick, H. Earl: High and Low Power Roentgenographic Differentiation Between Diverticulitis and Cancer of the Sigmoid. N. Y. State Jour. Med., 34, No. 24, 1075, December 15, 1934.

[2] Eggers, Carl: Diverticulitis and Sigmoiditis. ANNALS OF SURGERY, 94, No. 4, October, 1931.

[3] Edwards, Harold C.: Diverticula and Diverticulitis of the Intestine: Their Pathology, Diagnosis and Treatment. Wm. Wood, Medical Books, Baltimore, 1939.

DISCUSSION: DR. JOHN E. JENNINGS (Brooklyn) asked if Doctor Eggers would explain the difference in mortality of the operated and nonoperated cases. He pointed out that the nonoperated cases seemed to show a higher survival than those that were operated upon, and said that this corresponded to his own experience. He also said that he had noted that acute, fulminating cases of diverticulitis have been more often left-sided than right-sided, and that these cases are often erroneously diagnosed as ruptured appendices that

had abscessed. One should avoid, insofar as possible, the brusque invasion of the left abdomen.

DR. CARL EGGERS (New York) in closing stated that he was a firm believer in conservative treatment, and that operation should be reserved for cases with persistent symptoms, complications, or associated lesions. These include perforation, obstruction and carcinoma. Some of the patients in Doctor Eggers' series were operated upon under the mistaken diagnosis of acute appendicitis, others were acute surgical emergencies with peritonitis or abscess. Of the 12 perforations with peritonitis which were operated upon, four recovered completely, six died in the hospital, and two succumbed a long time after operation as the result of complications. Of the seven perforations with abscess, five recovered and two died. In one of these, the abscess dissected retroperitoneally and pointed in the opposite groin. The total immediate mortality in the 34 cases operated upon was 23.5 per cent, and was restricted entirely to acute perforations. There was no mortality in any of the operations of choice. The total mortality was 19.5 per cent, including five carcinoma cases. Deducting these, the death rate was 13.4 per cent, with or without operation.

LYMPHOGRANULOMA VENEREUM*

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THE PRESENT STATUS of lymphogranuloma venereum has evolved, through many years of clinical study, from a disease of the external genitals associated with inguinal and rectal lymphogranulomata. It came to be realized that the disease was not syphilis, gonorrhea or chancroid but may be associated with any one or all of them, and possessed a specificity for the Frei test.[1] †

Since 1930, lymphogranuloma inguinale has received particular attention in the American literature. Clinical cases are now recognized and hospitalized in increasing numbers in the wards of hospitals in the larger cities. At Bellevue Hospital (Third Surgical Division) lymphogranuloma inguinale appears in the files for the first time in 1934.‡

A. Stillman,[2] J. Morris,[3] and R. Colp[4] have made contributions before the New York Surgical Society. Stillman, in 1934, reported on the advantages of colostomy, Morris, in 1938, showed an excellent result from abdominoperineal resection of the rectum and the rectosigmoid, and Colp, in 1939, exhibited a case upon whom he had performed an abdomino-endo-anal resection of rectum and rectosigmoid.

Venereal lymphogranuloma, caused by an ultramicroscopic bacterium, may be regarded at present as a bacteriemia. It is transmitted through contact and has been recognized on the tongue[5] and on the surgeon's finger,[6] but predominantly on the external genitalia. The Frei test is positive after two to nine days[7] of incubation. Three days to three weeks after exposure, a primary sore appears on the genitals.[8, 9] This disappears in five to ten days[9] and is followed by inguinal node involvement in the male, rarely in the female. The skin over the nodes is purplish. Chills, fever, and night sweats appear with the perilymphadenitis. There are leukocytosis, relative mononucleosis, and eosinophilia.[9] Abscesses and sinuses appear in the groins and a thick, creamy-yellow, later, sanguineous pus exudes. As the chronic stage develops there occur elephantiasis of the vulva, penis, and scrotum, and rectovaginal thickening. The general surgeon is particularly concerned with the chronic stage and with the ulcerative stenosing proctocolitis that ensues. The patient com-

* Read before the New York Surgical Society, October 25, 1939. Submitted for publication October 7, 1939.

† D'Aunoy and von Haam estimate the diagnostic error of the Frei reaction at less than 10 per cent on the basis of a two-year study of 1,697 examinations. Positive Wassermann reactions were present in 19.5 per cent of positive Frei cases; acute gonorrheal and chancroidal infections in 10 per cent (Am. Jour. Clin. Path., Baltimore, 6, 529, 1936).

‡ At the present time, it is the practice on this division to have Frei tests on all inflammatory rectal cases and all problem cases with abdominal pathology.

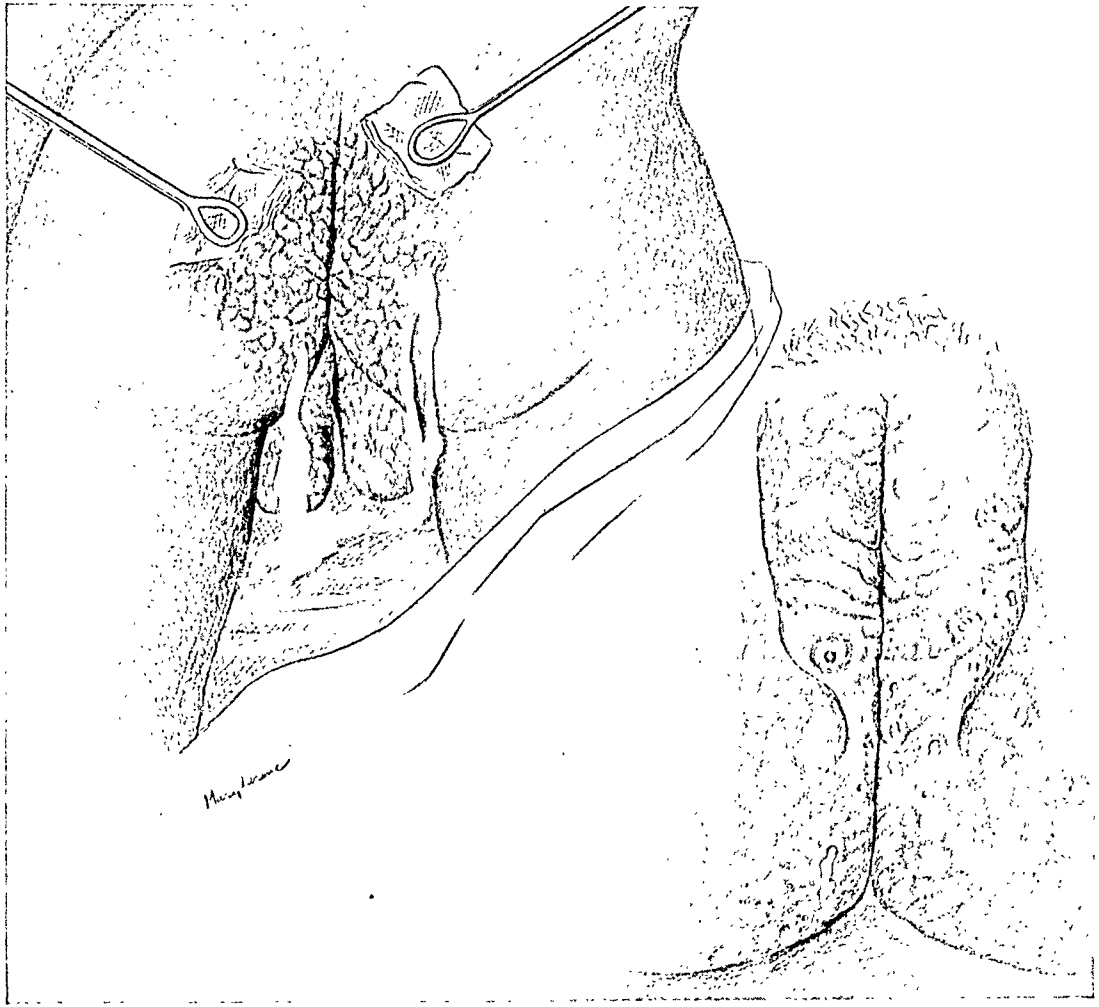


FIG. 1.—Drawing illustrating elephantiasis of vulva and perineum. Note sinuses and fistulae.

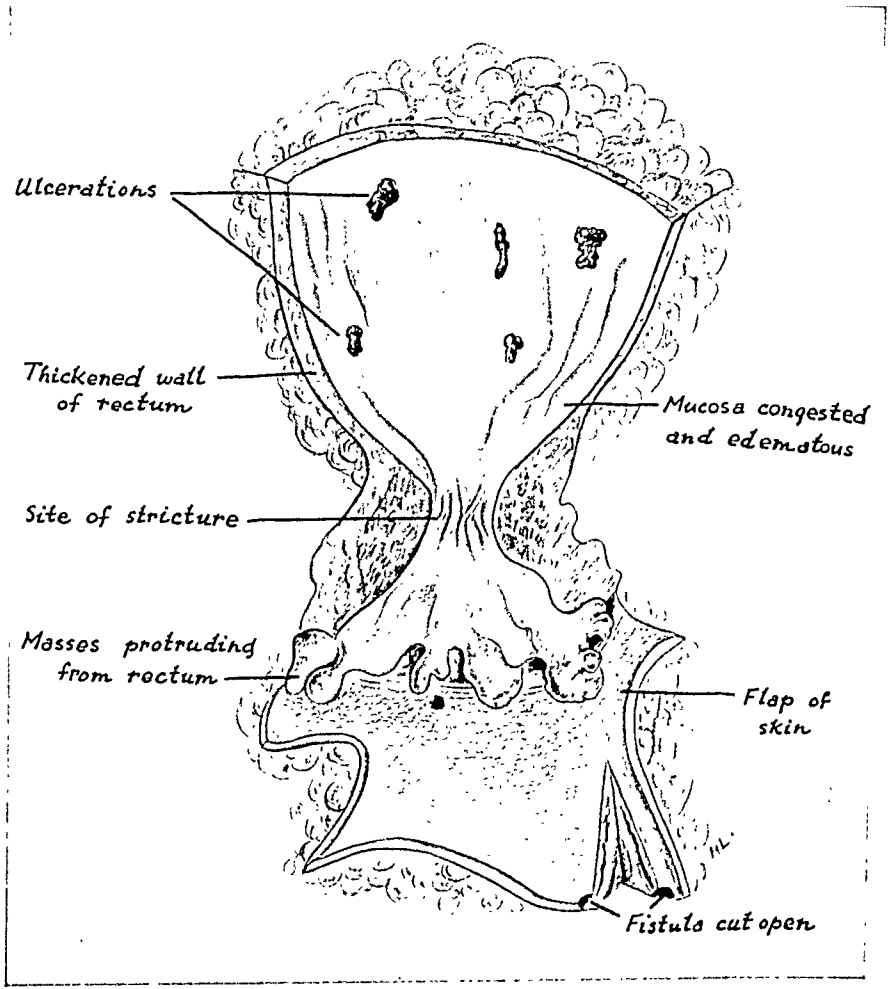


FIG. 2.—Lymphogranuloma. Drawing representing perirectal thickening and stenosis, fistulae, and ulcerations.

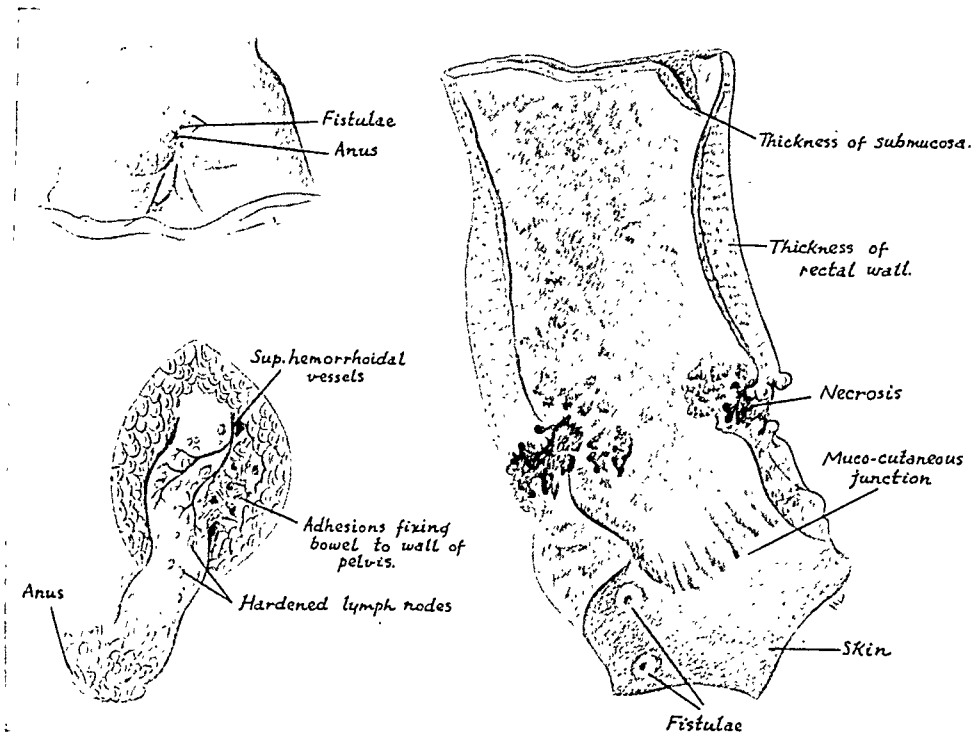


FIG. 3.—Lymphogranuloma Venereum. Drawing illustrating rectal fistulae, in upper left. Perirectal thickening and necrotic areas to the right of mesorectum and enlarged discrete nodes about superior hemorrhoidal artery, in lower left. To the right, the specimen is represented. Note especially extensive necrosis in lower rectal wall and marked thickening above.

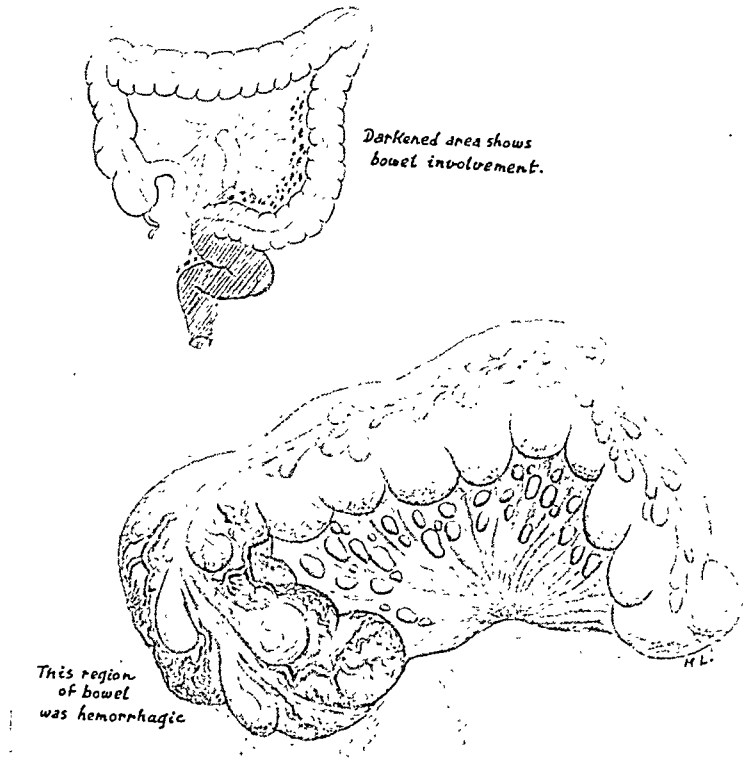


FIG. 5.—Extensive Lymph Node Metastases. One of the lymphogranulomata complicated by adenocarcinoma of the rectosigmoid. Note enlarged nodes in mesosigmoid and retrocolic tissue extending to region of splenic flexure.

plains at this time of pain and purosanguineous discharge from the rectum, inability to move the bowels, and general debility and asthenia.

The present review comprises 55 cases admitted on the surgical wards of the Third Division. It does not consider those treated on the nonsurgical wards. Of these 55 cases, 35 underwent resection of the rectum and variable amounts of sigmoid colon. These latter constitute the basis for this paper.

The average age of the total cases was 36.5 years, the oldest being 68, the youngest 20. There were 16 males and 35 females. Forty-three were Negroes and 18 Caucasians. The mean duration of the perineal symptoms was 3 years in 42 cases and 4.2 years for 18 of the resected cases. Lymphogranuloma venereum attacks all ages and is distributed throughout the world. Any reported statistics must vary with the population affected. The present data are characteristically both metropolitan and of a low social order.

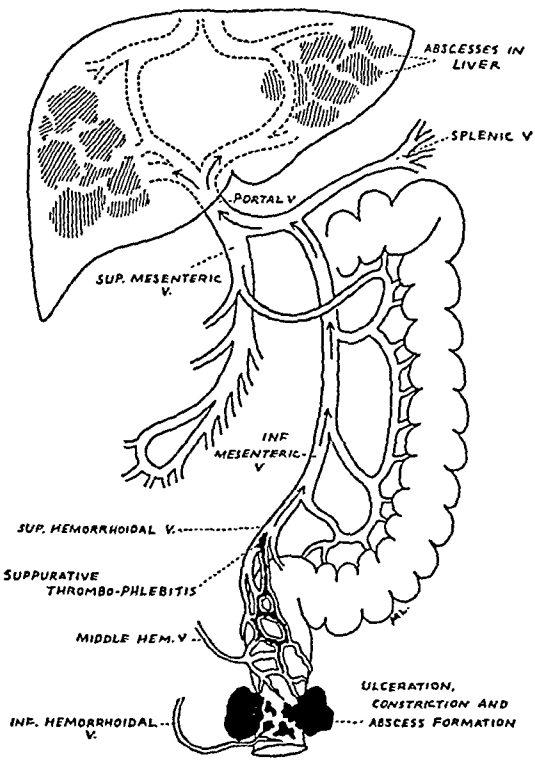


FIG. 4.—Diagrammatic drawing representing active granulomatous process in rectum and occasional means of spread through superior hemorrhoidal vein and portal system to liver. Necropsy revealed abscesses in liver as indicated.

The infectious process is essentially lymphatic in its spread. It enters the lymphatics accompanying the inferior, middle, and superior hemorrhoidal arteries. So many of the patients observed by us are females in whom the initial lesion is generally so high in the vaginal vault that only an occasional patient presented enlarged inguinal nodes. But there were sites of maximum damage and repair in the lower rectum, within a finger's length of the mucocutaneous junction and contiguous with the posterior vaginal wall. Here, stenotic scar or perforating ulcers occurred. Many of these ulcers communicated with the vagina. In an occasional case the perforation extended completely about the rectal wall so as to separate the anorectum from the upper rectum. The perirectal tissues supplied by the middle hemorrhoidal lymphatics appear to be next seriously involved and for some unknown reason those on the right side more than those on the left. Fan-shaped masses of fibrotic tissue interspersed with necrotic foci, evidently disintegrated lymph nodes, were observed to point from the lateral walls of the midrectum beneath the deep fascia and close to the periosteal surfaces of the floor of the true pelvis. When these "fixating" shafts of inflammatory tissue were divided in the course of rectal dissection, one or more sinuses appeared. In addition to these sinuses or blind fistulae several external fistulae proceeded from the rectum and discharged externally on the surface of the

perineum, as represented in Figures 1, 2 and 3, and described in the pathologic findings. Finally, the pararectal and mesorectal fat and lymphatics, at the level of the superior hemorrhoidal arteries, were demonstrably involved but to a lesser extent than those of the middle and inferior hemorrhoidals. There were edema and hyperplastic nodes. The extent of the lymphadenitis within the abdomen varied from barely palpable nodes in the presacral area to the general enlargement of the retrocolic nodes of the sigmoid and descending colons.

In the extreme case these stages of lymphatic involvement are not recognizable but the whole rectum, posterior vaginal wall, and pararectal and presacral tissues are generally necrotic and suppurative. The infection has spread on into the abdomen and the general condition is so depleted that exitus is imminent whether dependent pelvic drainage is attempted or not.

Another means of dissemination, which is less frequent, is that by way of the superior hemorrhoidal and pelvic veins. This was well illustrated in an autopsy performed on an advanced case. Figure 4 shows the thrombophlebitis of the inferior mesenteric vein and the multiple intrahepatic abscesses found in this instance. In a few of the cases perihepatic adhesions and peripherally scarred livers were observed in the open abdomen. It was thought that bacteriemia existed in the portal circulation and was taken care of by the liver even at the expense of liver damage. Where the infection broke through into the general circulation, and positive cultures were obtained, the patients were too acute for operation.

In addition to the involvement of lymphatics and veins arising from the site of original contamination the mucosa of the anorectum, sigmoid, and rarely the descending colon showed inflammation, most often ulcerative. It is not known whether this ulcerative colitis was due to the lymphogranuloma virus or to a secondary infection. The ulcers are quite generally regarded as nonspecific. Many colonic ulcers occur with relatively minor pathologic changes in the rectum. All the cases but two, of the 35 resections, were associated with a positive Frei test.

The pathology in this group of malignant inflammations of the rectum is strikingly similar and in no way specific. Thirty-five specimens were examined. In 33 of these the Frei test was positive. In these the change was a chronic productive inflammation with marked fibrosis and with small focal abscesses. Stricture was present in all, starting at a point immediately above the internal sphincter and extending for variable lengths up to the rectum and colon. In 30 cases the lesion was below the peritoneal reflection, usually being confined to the lower 12 cm. Two cases showed involvement of the sigmoid and descending colon. Both of these had had colostomies, the stomata of which were closed by extension of the inflammatory process.

In 26 cases the anal and perianal skin was involved, 22 showing one or more fistulous openings. In one case there were eight separate external openings. In six cases there was no involvement of the sphincters or perianal tissue.

Annular ulceration of the mucosa was uniformly present, extending the entire length of the stenosis. The degree of stricture varied. In ten cases the rectal lumen appeared as a tortuous canal, in places measuring less than 0.5 cm. across. In the other 25 cases the stricture was not as marked.

Microscopic examination showed complete loss of mucosa with a superficial slough composed of disintegrating tissue cells and pus. Beneath this there was a basic framework of new fibroblasts and new blood vessels with a heavy infiltration of lymphocytes and plasma cells. Occasional small abscesses were present. Deeper in, the tissue fibrosis was more marked, cellular infiltration less dense and there was a tendency toward perivascular infiltration. Fewer abscesses were seen. The reaction appeared less active than that near the lumen. Throughout the tissue multinuclear giant cells of the "foreign body" type were seen. At the upper limits of the lesion the inflammatory reaction had extended well beyond the area of ulceration. Here the reaction was most marked in the submucosa with a perivascular reaction in the muscle layers.

Two cases showed carcinoma, one, squamous cell, involving the mucocutaneous junction at the level of the internal sphincter, and the other, an adenocarcinoma, involving the ampulla of the rectum.

Two cases had a negative Frei test. In both, the inflammatory process was confined to the anal canal, perianal tissue and lower 6 cm. of the rectum. The skin about the anus was thrown into condylomatous formations with multiple sinuses leading toward the rectum. There was dense infiltration of lymphocytes and plasma cells in the epidermis, dermis and subcutaneous tissue. Histologically, this lesion appeared identical with those previously described. In one of these cases a positive clinical diagnosis of granuloma inguinale had been made.

The complications included five cases of arthritis or an incidence of 9 per cent in these surgical lymphogranulomata, which is far greater than 1.6 per cent of 186 cases from the Dermatologic Service for a corresponding period. McEwen[10] found no permanent damage in these joints. From his studies in these cases he was inclined to regard them as a definite manifestation of lymphogranuloma venereum.

Carcinoma followed the rectal granulomata in three of the 35 resected cases* (Fig. 5). Five of the operated cases were psychotic. Unless the progress of the infection is checked they become profoundly prostrated and die of sheer exhaustion, go on to complete obstruction, peritonitis, meningitis,† or general sepsis.‡

* Since the preparation of the present communication, four additional resections, including one for complicating carcinoma, bring the incidence of malignancy associated with lymphogranuloma venereum to 8.6 per cent. Also ref. David, V. C., and Loring, M., *et al.* ANNALS OF SURGERY, 109, No. 5, 837–843, May, 1939.

† The virus of venereal lymphogranuloma seemingly has a special affinity for the nervous tissues. (Pisacane, C., and Lopresti, R.: Riforma Medica, Naples, 55, 332, March 4, 1939; also Levy-Valensi and Seze, S. de: Presse Medicale, Paris, 47, 593, April 19, 1939.)

‡ See opposite page.

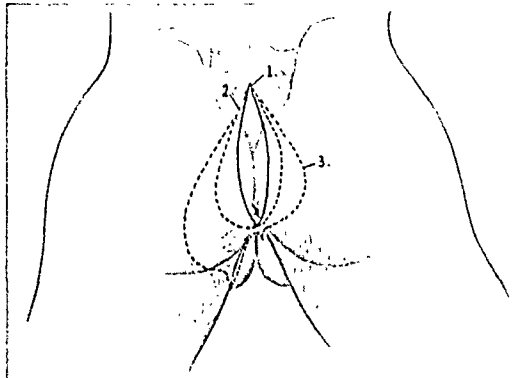
The prognosis, therefore, is bad for the case refractory to palliative therapy unless operated upon. Of these surgical cases the prognosis is not good in the presence of nodular enlargement above the sigmoid colon or with gross liver pathology or with bacteriemia or meningeal symptoms.

The treatment was necessarily surgical in all these cases, as medical treatment, including chemotherapy and vaccines, had long been tried and had failed. The paramount indication was taken to be drainage. There was so much massive suppuration and necrosis in and about the anus, rectum, and sigmoid that nothing short of resection of the rectum, to, and including the rectosigmoid junction and the grossly infected necrotizing pararectal tissues, could effect satisfactory drainage. Palliative operations for hemorrhoids, fistulae, and strictures were performed on the early cases but always with the understanding, in the Frei positive cases, that the process would progress and require surgical excision at a later date. There is no question that colostomy alone is helpful in lymphogranuloma.* Between the stages in the present series definite improvement in the ulcerative colitis and a partial clean-up of the perineal suppuration were repeatedly observed. But on the other hand the infection buried in the pelvic lymphatics and fascial planes behind and below the peritoneum is allowed to smolder, increase, and be absorbed. Such patients have pain and discharge, become toxic and asthenic. Patients colostomized, elsewhere, have applied for assistance too prostrated for any further surgery. In two of these the original colostomy ceased to function as the granulomatous process had crept up to, and involved, the sigmoidostomy stoma. One such case was admitted to die of intestinal obstruction. It is true that no procedure can help many of these wretched people but it is encouraging to observe the striking improvement in the great majority of our patients in the short time in which they have been followed.

It is surprising, and seemingly contrary to general surgical experience, to observe the rapid healing of these contaminated sacroperineal wounds. We are aware that all fistulous tracts are not always primarily removed in their entirety. Many cases continue to drain for several weeks. Subsequent incisions, during the process of healing, expose the source of reinfection and

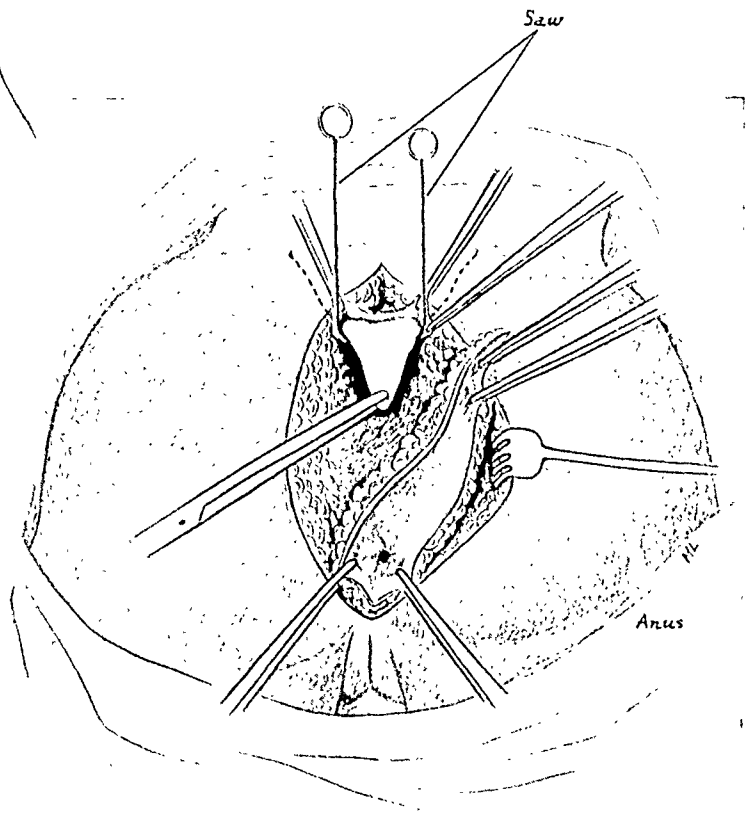
‡ In two of the five hospital deaths *Streptococcus haemolyticus* was recovered from the blood several days antemortem. We are inclined to believe, at the present writing, that the various micro-organisms recorded as having been obtained from the blood and spinal fluid, joints and peritoneum, and from the intestinal mucosa are secondary invaders which have naturally followed in the wake of a lowering resistance produced by the etiologic agent of this disease. It may be significant that the intestinal nodes uniformly react—reach a certain size (not over 1–1.5 cm.) and consistency and remain discrete, then necrose, whether presacral or retrocolic. These are quite different from those met with in the groins during the acute stage of mixed infections or in the regional metastases of carcinoma. Possibly, future studies of this unknown causative factor along biologic lines, in addition to the routine clinical and bacteriologic methods, may throw more light upon it.

* Compare the experience of H. W. Cave with chronic ulcerative colitis. (J.A.M.A., 113, No. 7, 551, August 12, 1939.



I(a). Types of incisions

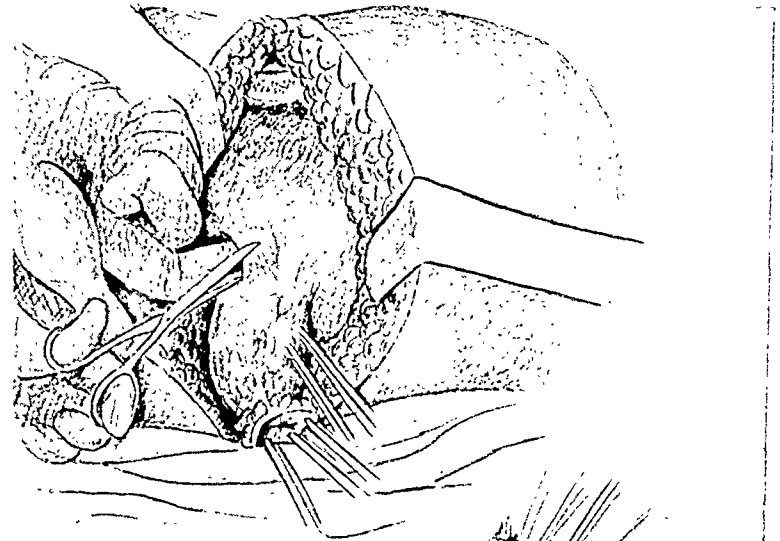
Coccyx and lower sacrum (Rest of sacrum in dotted line



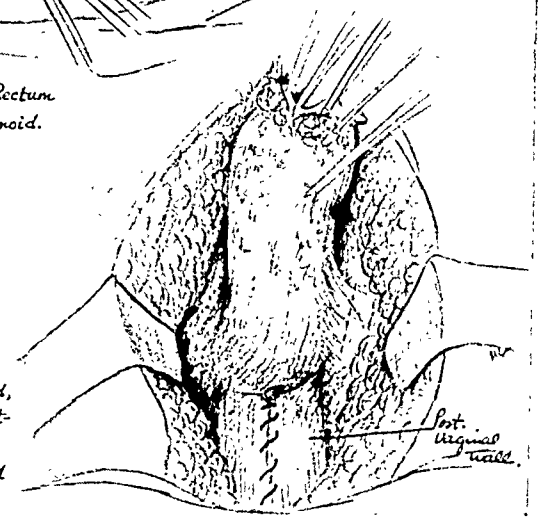
I(b) Incision and removal of Coccyx and lower sacrum.

FIG. I(a).—The incision is carried from the third sacral vertebra downwards about anus so as to include the perirectal inflammatory tissue and fistulous tracts.

FIG. I(b).—The skin flap is mobilized. Anal opening is closed by suture or by clamping together edges of detached skin over it to prevent soiling of wound. Coccyx and lower sacrum are removed to afford a free approach to the presacral tissues and rectosigmoid.



II. Dissection of Rectum and Recto-sigmoid.



III.

Rectum thrown forward, exposing sutures in posterior Vaginal wall for repair of Recto-vaginal fistula.

FIG. II.—The rectum is being mobilized after division of levatores ani and dissection of perirectal fasciae.

FIG. III.—The rectum is brought upwards to facilitate repair of the posterior vaginal wall for rectal fistula.

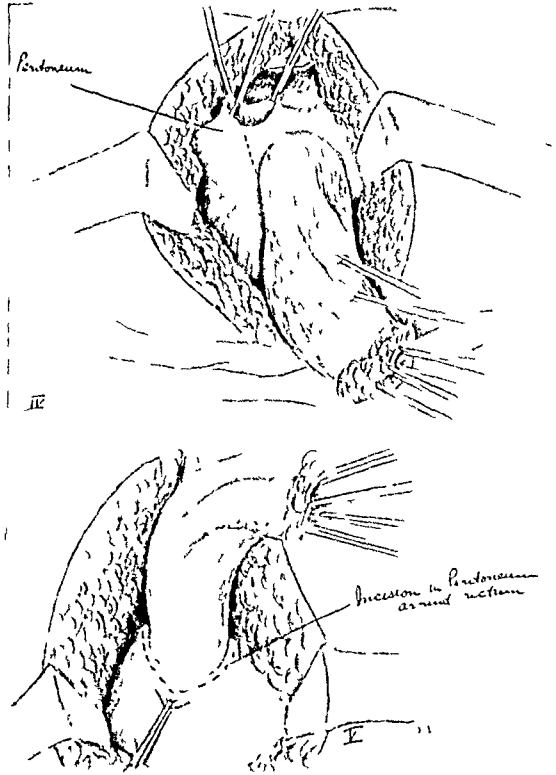


FIG. IV.—The rectum is drawn downwards, exposing the rectal peritoneal relations.

FIG. V.—The rectum is elevated, disclosing the line of incision in the peritoneum about the rectal wall.

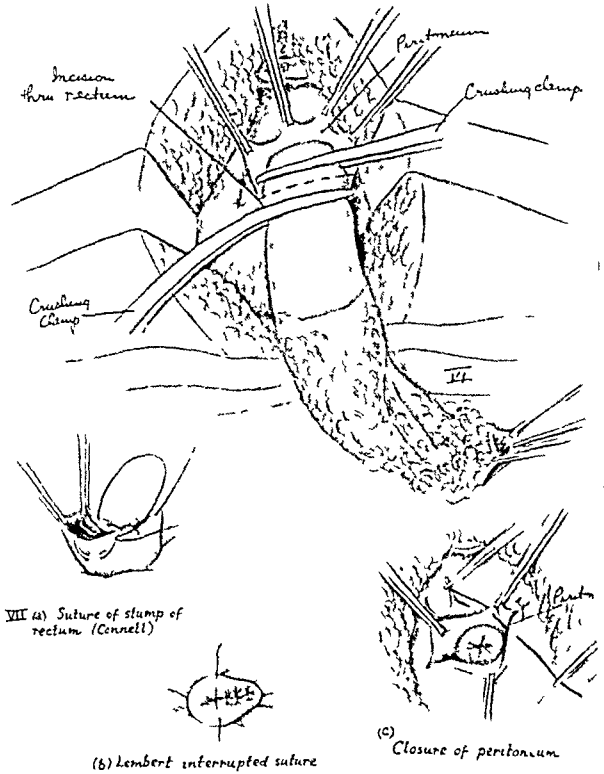


FIG. VI.—The rectum and the lower portion of the pelvic colon are delivered after freeing the peritoneal and mesorectal attachments.

FIG. VII(a), (b), and (c) show the successive steps in the treatment of the proximal stump of the pelvic colon and the closure of the peritoneum underlying it.

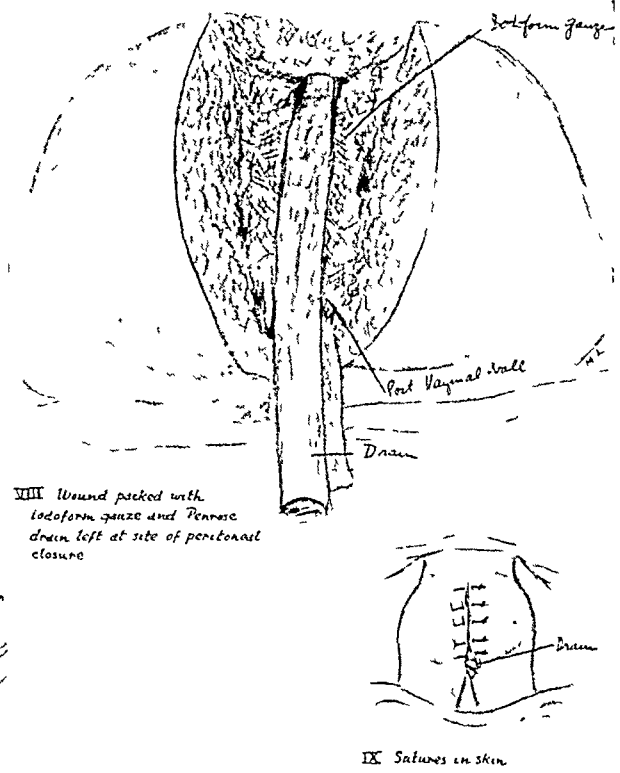


FIG. VIII.—The wound is prepared for suturing. Note the drains at the site of the peritoneal closure carried out through the lower angle of the wound.

FIG. IX.—The skin and the soft parts are approximated by a single layer of interrupted sutures.

maintain the drainage. One of these patients returned to our wards with a diagnosis of malignancy from another hospital, but subsided after ample pelvic drainage was reestablished. Another case generally improved in weight and well-being presented a continuously necrotic discharge at the upper posterior extremity of the wound. Repeated incisions, finally carried into the third lumbar intervertebral region, and prolonged open drainage were followed by complete healing. Although roentgenograms were negative, there were bony grating and probably superficial osteoperiostitis. This was believed to demonstrate, more strikingly than in the pelvis, the burrowing of the lymphogranulomatous process into the soft parts and the resistance of bone.[11] One feels that there is certain virtue in uncovering these concealed infectious pathways and letting in air and light. With the exception of these occasional cases, with deeply concealed and inaccessible sinuses, the convalescence has been very encouraging. Sacroperineal resection, leaving a sacral anus, was performed in four of the earlier cases. It was soon realized that it was impossible to determine the degree of sigmoidal involvement without celiotomy. To avoid subsequent colostomies at a higher plane, all subsequent cases were celiotomized. Colostomy was performed about ten days prior to resection. It was fashioned after Mikulicz in those (three cases) in whom some hope remained of restoring the perineal route or of preserving the natural anus. A permanent abdominal anus was made in the advanced cases. Twenty-eight of these cases were of this latter category.

We have come to the conclusion with Lynch,[12] and others, that posterior resection above the anal sphincter is unwise. The firm cartilage-like scar following terminal anastomosis is, in our experience, about as troublesome as the original stricture. And denervation of the sphincter seems to further interfere with satisfactory function. We prefer to leave certain of these patients, and those who require it, with artificial sacral ani. Unless the formation of a sacral anus was effected at the time of the sacroperineal resection none was created at all for no changes from an abdominal to a sacral anus has subsequently been made in this series. Whether left with a sacral or an abdominal left rectus colostomy, the patient is taught, by the charge nurse, the care of the bowel and is instructed in the diet so that the patient is prepared to continue the new hygiene at home.*

No artificial bags of any kind are advised. Simple cleanliness, kaolin, and dry gauze make up the essentials of the colostomy dressings.

These patients generally improve in morale, in body weight, and return to habits of living similar to those enjoyed before the onset of the disease.

With the exception of five extreme cases all the remainder of the 35 resections survived. This gives an hospital mortality of 14.3 per cent. There were no immediate postoperative deaths.

* The authors wish to take this occasion to express their sincere appreciation for the faithful and self-sacrificing attention given these patients by Miss Katherine Gannon, R.N., and her associates.

SUMMARY

(1) Lymphogranuloma venereum has been reviewed as presented on the Third Surgical (N.Y.U.) Division, Bellevue Hospital, 1936–1939.

(2) The total observed included a few direct admissions under some other classification but was largely made up of transfers from the Dermatologic, Medical, and Gynecologic wards in the hospital.

(3) The surgical treatment was radical for the obstructed case and palliative for the inflamed but nonobstructed one.

(4) Of 35 resections, four were one-stage sacroperineal and 31 were abdominal colostomies followed by sacroperineal resections.

(5) The hospital mortality was 14.3 per cent.

(6) The convalescence in the uncomplicated case was remarkably favorable.

The authors gratefully acknowledge the cooperation of Drs. Arthur M. Wright and Douglas Symmers, of Drs. F. M. Harrison, J. Lawler, J. Croce and the other members of the Third Surgical Division, Bellevue Hospital; and the expert technical assistance of Miss Mary Lorenc.

REFERENCES

1 Frei, Wilhelm: Klin. Wchnschr., 4, 2148, November 5, 1925.
2 Stillman, A.: ANNALS OF SURGERY, 101, 1284, May, 1935.
3 Morris, J.: Reported before N. Y. Surg. Soc., November 23, 1938.
4 Colp, R.: Abdomino-Endo-Anal Resection of Rectum and Rectosigmoid for Lymphogranuloma Venereum. Reported before N. Y. Surg. Soc., March 1, 1939.
5 Bloom, D.: Arch. Dermat. and Syph., 28, 810, December, 1933.
6 David, V. C., and Loring, M.: J.A.M.A., 106, No. 22, 1875–1879, 1936.
7 Prehn, D. T.: Arch. Dermat. and Syph., 35, 231, February, 1937.
8 Hellerstrom, S.: Acta dermat.-venereol., Supp. 1, 5–224, 1929.
9 Thompson, R. M.: J.A.M.A., 106, No. 22, 1869–1875, 1936.
10 McEwen, C.: Personal communication.
11 Wright, L. T., and Logan, M.: Osseous Changes in Lymphogranuloma Venereum. Arch. Surg., 39, 1–170, July, 1939.
12 Lynch, J.: Personal communication.

A GASTRIC SECRETORY DEPRESSANT IN EXTRACTS OF ACHLORHYDRIC CARCINOMATOUS STOMACHS*

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A PLAUSIBLE HYPOTHESIS to explain the inhibited gastric secretion and achlorhydria in certain carcinomatous stomachs is that some gastric secretory inhibitor is elaborated either as a factor associated with pathologic conditions which precede or accompany the development of the neoplasms or as a factor identified with an hyperactive normal mechanism for inhibition of gastric secretion. Such an hypothesis has been mentioned at times in the literature[1] but has not been studied experimentally except for a report by Brunschwig, J. van Prohaska and Clarke.[2] These authors injected achlorhydric gastric juices from patients with carcinoma of the stomach into dogs with gastric fundus pouches which had been stimulated by feeding, and observed a transitory marked inhibition of volume of secretion and achlorhydria in 78 per cent of the 27 samples tested as compared with approximately 20 per cent in controls. Similar results were obtained using achlorhydric juices from patients with pernicious anemia.[3]

The method of studying factors which might influence gastric secretion by the intravenous injection of the substance to be tested into gastric-pouched dogs is a classic mode of experimentation in gastric physiology. As in the previous studies with gastric juices, such animals were employed in the following experiments, but instead of injection of gastric juices extracts of carcinomatous stomachs were employed.

Preparation of Extracts.—In the original work of Edkins[4] 0.2 per cent HCl extracts of gastric mucosa, when injected intravenously, were observed to stimulate gastric secretion in an anesthetized animal. This stimulating factor was called "gastrin." Since his publications in 1910, the existence of "gastrin," as a substance apart from histamine, has been the subject of controversy, but it would appear from the recent report of Komarov[5] that "gastrin" and histamine are not identical. In the following studies, Edkin's

* Presented before the Third International Cancer Congress, Atlantic City, N. J., September 11 to 15, 1939. Submitted for publication September 26, 1939.

This work was conducted under grants from the International Cancer Research Foundation, Philadelphia, Pa., and from the National Advisory Council on Cancer of the U. S. Public Health Service, Washington, D. C.

† Research Assistants, International Cancer Research Foundation Grants.

method of extraction was followed. It was felt that if clinically, under stimulus by histamine, the human carcinomatous stomachs were achlorhydric, a secretory depressant action observed with extracts obtained by the technic employed to recover a gastric secretory stimulant, would perhaps be of greater significance than if another method of extraction were employed.

Thus, in carcinomatous stomachs removed at necropsy in the Department of Pathology of the University of Chicago, or partially resected at operation, the mucosa was stripped from the muscularis, cut into small pieces and ground

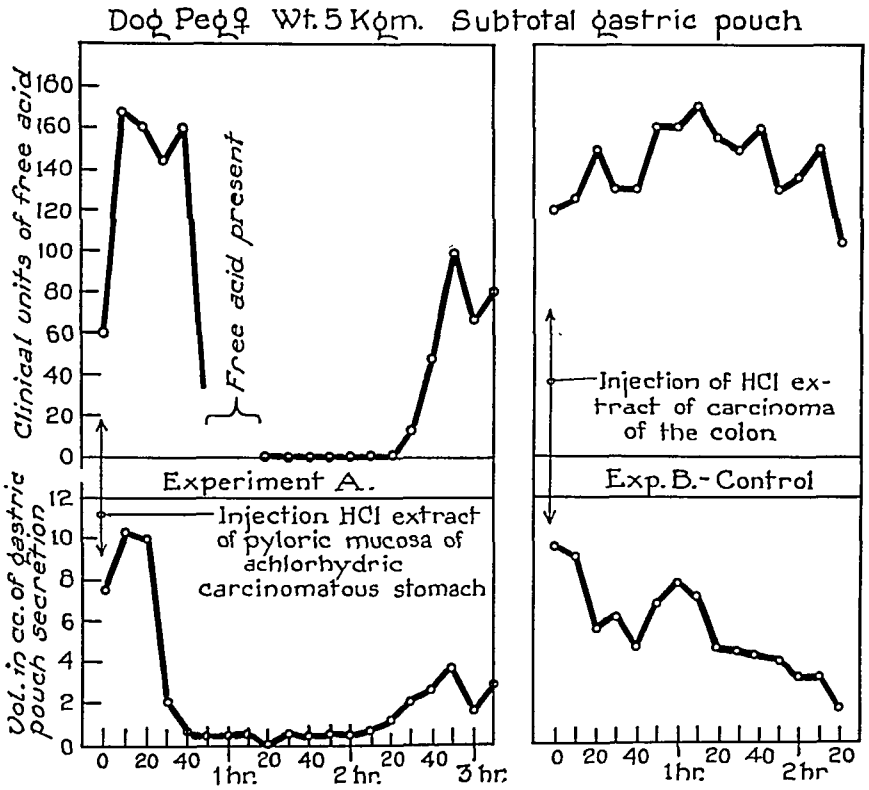


CHART 1.—Showing suppression of gastric pouch secretion and transitory achlorhydria due to injection of 0.2 per cent HCl extract of pyloric mucosa of an achlorhydric carcinomatous stomach. Graphs of a control experiment, in which acid extract of a carcinoma of the colon was employed, are also shown. In each of these experiments the animal was given one large feeding at the beginning of the experiment and no subsequent feedings.

in a mortar with sand. Two-tenths per cent HCl, or distilled water, was added in proportion of 50 cc. per 12 grams of tissue. The mixture was boiled in a Kjeldahl flask for ten minutes, allowed to stand overnight at room temperature, centrifuged, the supernatant cloudy fluid decanted and neutralized to litmus with NaOH. Distilled water was added to make up to original volume. Upon neutralization, a flocculent precipitate developed. The extracts were stored in an oven kept at 56° C. Before use, the extracts were shaken to obtain a uniform dispersion of the precipitate.

As a rule, the carcinoma was grossly resected from the stomach and extracted separately. However, histologic studies showed that the growth

had practically always extended beyond the gross limits into the surrounding mucosa and that extracts of mucosa could not, therefore, be regarded as free from material from the neoplasm. Thus, results using either mucosa or tumor are tabulated together.

Method of Experiment.—The dogs with gastric pouches were placed upon a large table, allowing freedom of motion and access to water. Soxlet flasks were suspended beneath the cannulae. Pieces of lean cooked meat were fed at ten- to 20-minute intervals, throughout the periods of observation. When vigorous acid secretion from the cannulae became established, the samples were collected at ten-minute intervals, the volume recorded, and titrated for free and combined acid, using 10/N NaOH and Töpfer's reagent and phenophthalein as indicators, respectively.

The extract to be employed was then injected in proportion of 1 cc. per kilo body weight (arbitrary dose). The animals were observed for at least two hours when no depression of pouch secretion occurred, and until free acid returned if a period of achlorhydria did develop.

Frequent rectal temperatures were recorded since in "fresh" animals a rise in temperature to above 40.5° to 40.6° C. was sufficient to produce suppression of secretion and achlorhydria on a thermal basis alone. Where such temperatures occurred the experimental results were discarded and the animal "immunized" to fever-producing substances in the extracts by repeated daily injections of small doses of the extracts. In some instances, temperatures above 40.5° C. always occurred but the gastric secretory mechanism became "heat resistant." Such dogs could be used once this stage was reached. In some such animals acid-pouch secretion was observed to continue even though the temperature reached 42° C.

Inhibition of pouch secretion and liberation of free acid followed the injection of some extracts from carcinomatous stomachs and some controls. The latent period for this varied from 30 to 70 minutes and occasionally was 100 to 120 minutes. A reduction in secretion volume to four drops or less for at least two ten-minute periods with persistence of free acid was regarded as significant and recorded as a +-result. Reduction in free acidity to 25 clinical units, or less, where the preinjection concentration of free acid was 60 or more clinical units was also considered a +-result. Reductions of free acidity from higher levels to 40 or 50 clinical units were not regarded as significant. Actual achlorhydria lasting ten to 30 minutes was recorded as a ++-result; achlorhydria lasting 30 to 60 minutes was considered as a +++-result; and achlorhydria lasting for 60 or more minutes was regarded as a ++++-result.

In biologic experiments of this type, where crude test extracts are used and where a number of known and unknown factors contribute to vary the conditions of each experiment, a variation in results is to be expected. Consequently, arbitrary criteria were established for the recording of results. For example, at least three different dogs (and often more) were employed to test a given extract, and an attempt made to perform at least five separate

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experiments with a given sample. An extract from an achlorhydric carcinomatous stomach was not tabulated as positive, that is, as containing a gastric secretory depressant, unless at least three positive experiments, using at least two different animals, were obtained. In regard to the controls, the criteria were not as strict, since if two positive experiments were obtained, the extract was regarded as containing a gastric secretory depressant.

Experiment A.—Summarized in Table I: Of 22 achlorhydric carcinomatous stomachs, 11, or 50 per cent of the series, contained the secretory depressant; 156 individual experiments were performed

TABLE I

SUMMARY OF RESULTS OBTAINED WITH BOILING WATER OR 0.2 PER CENT HCL EXTRACTS OF 22 ACHLORHYDRIC CARCINOMATOUS STOMACHS

	Patient	No. of Expers. Performed	Results
1	Boh	3	3 ++++
2	Liss*	8	3 ++++, 3 +++, 2 −
3	Gur	5	5 −
4	Young	6	4 ++++, 1 ++, 1 −
5	Litwin	6	2 ++++, 1 +++, 3 −
6	Behn	7	1 ++++, 2 +, 4 −
7	Brash	6	6 −
8	Reid	9	9 −
9	Benhn	7	7 −
10	Kruse	6	6 −
11.	Holsw	8	8 −
12	Marc	9	3 ++, 6 −
13	Herbd	7	7 −
14	Weav.	8	3 +, 5 −
15	Saks	14	2 +++, 1 ++, 3 +, 8 −
16	Han†	2	1 ++, 1 +
17	Boul	11	1 ++++, 1 ++, 3 +, 6 −
18	Edmund	10	1 +++, 1 + +, 1 +, 7 −
19	Bick	2	2 −
20	Loz ‡	7	1 +++, 1 +, 4 −
21	Lars‡	9	2 +, 7 −
22	Groeg .	5	5 −

* Maximum free acid with histamine = 20, considered as definitely hypochlorhydric and therefore, included in this group as a stomach whose secretions were inhibited as compared with the average normal.

† The small number of experiments performed here was due to the fact that the extract was obtained from a metastatic lymph node removed at operation from a patient with extensive inoperable carcinoma of the stomach

‡ These extracts are considered as negative for the gastric secretory depressant since only two and not at least three positive experiments were obtained in the series run with them

Experiment B.—Summarized in Table II: Of 12 carcinomatous stomachs secreting free acid, three, or 25 per cent, contained the secretory depressant; 80 individual experiments were performed.

Experiment C.—Summarized in Table III: A variety of control extracts were employed including those of stomachs from patients not exhibiting tumors or with tumors outside the stomach, and of a variety of neoplasms themselves. A total of 528 individual experiments were performed with a positive incidence varying from zero to 24 per cent, depending upon the group in question.

TABLE II

SUMMARY OF RESULTS OBTAINED WITH EXTRACTS OF CARCINOMATOUS STOMACHS WHICH CLINICALLY SECRETED NORMAL CONCENTRATIONS OF FREE HCL

Patient	Max. Free HCl (Histamine)	No. of Exper's. Performed	Results
1. Horwath.....	25 (Ewald test only)	6	3 ++++; 3 −
2. Yavitz.....	60	4	4 −
3. Sezeb.....	35	7	7 −
4. Sckm.....	55	6	6 −
5. Lev.....	40	9	1 ++++; 1 +++; 1 ++; 6 −
6. Kid.....	50	5	5 −
7. Urik.....	72	7	7 −
8. Pusat.....	30	8	8 −
9. Pop.....	50	3	3 −
10. Pal.....	110	7	7 −
11. Levins.....	110	8	3 ++++; 5 −
12. Schaub.....	82	5	5 −

TABLE III

SUMMARY OF INCIDENCE OF EXTRACTS CONTAINING GASTRIC SECRETORY DEPRESSANT

Extract	No. of Samples Tested	Per Cent with Gastric Secretory Depressant
Achlorhydric carcinomatous stomachs	22	50%
Carcinomatous stomachs secreting normal concentrations of free HCl....	12	25%
Stomachs from patients not presenting malignant neoplasms.....	39	16%
Stomachs from patients with malignant neoplasms outside the stomach....	34	24%
Carcinomata of the colon.....	17	12%
Colon mucosa adjacent to carcinoma of colon.....	11	0%

Prolongation of Achlorhydria by Repeated Injections of Gastric Secretory Depressant.—In order to rule out the possibility that the transitory hyposecretion and achlorhydria observed in some of the above observations was of the nature of a "shock reaction," and independent, to a large extent, of the quantity of extract injected, experiments were conducted in which positive extracts from achlorhydric carcinomatous stomachs were injected at frequent intervals, and in this manner the achlorhydria was prolonged, in one case for eight hours, depending upon the number of such injections. Repeated injections of positive control extracts also resulted in more prolonged hyposecretion and achlorhydria than when only one injection of the extract was made.

Discussion.—A number of factors that might have afforded inhibition of pouch secretion, other than some secretory depressant in the extracts, were considered and by experiment ruled out, such as prolonged depression of blood pressure, enterogastron produced in the usual manner,[6, 7] reduction in CO_2 combining power of the blood, high dextrose content in the extracts, usual bacterial toxins, temperature elevations in the test animals, *etc.* While some extracts, on occasion, produced severe depression or episodes of vomiting, these were by no means characteristic of the extracts from carcinomatous stomachs but were observed with control extracts as well. Depression and vomiting alone were not sufficient to cause positive results.

The incidence of positive control experiments is too large to be dismissed simply as "false positives." Furthermore, a review of the literature and our experiences have shown that a wide variety of unrelated substances such as urine, concentrated glucose solutions, extracts of various normal tissues, *etc.*, will, on occasion, when injected into pouch-dogs, produce transitory inhibition of gastric secretion and liberation of free acid. Atropine regularly produces such an effect. Thus, in an evaluation of the data obtained in the above experiments, it is necessary to bear in mind that an appreciable incidence of "nonspecific" positive experiments are obtained in a study of this kind.

The incidence of positive extracts from carcinomatous stomachs, which secreted normal or high acid gastric juice, closely approximates the incidence found among control stomachs from patients without neoplasms anywhere in the body. This, of course, is what might be predicted if the premise is accepted that achlorhydria accompanying gastric cancer is due to a local excess of a gastric secretory inhibitor; for if a stomach continues to secrete normal or high concentrations of free HCl although developing a cancer, a series of such stomachs should (and did) yield results practically identical with a series of experiments performed with stomach extracts from patients not presenting neoplasms anywhere in the body.

CONCLUSIONS

Boiling water or 0.2 per cent HCl extracts of the mucosae and neoplasms or achlorhydric carcinomatous stomachs, when neutralized and injected intravenously in dogs with stimulated gastric pouches, resulted in a marked depression of pouch section and achlorhydria with 11 or 50 per cent of 22 extracts studied. Similar depressant effects were noted with 14 or 19 per cent of 73 extracts of stomachs not presenting benign or malignant neoplasms.

BIBLIOGRAPHY

[1] Polland, W. S., and Bloomfield, A. L.: Gastric Secretion in Cancer of the Stomach. Bull. Johns Hopkins Hosp., 46, 307, 1930.

[2] Brunschwig, A., Clarke, T. H., and Prohaska, J. van: A Secretory Depressant in Achlorhydric Juices from Carcinomatous Stomachs. Surg., Gynec., and Obstet., 70, No. 1, 31, 1940.

[3] Brunschwig, A., Prohaska, J. van, and Clarke, T. H.: A Secretory Depressant in the Gastric Juices of Patients with Pernicious Anemia. Jour. Clin. Invest., 18, No. 4, 415, 1939.

[4] Edkins, J. S.: The Chemical Method of Gastric Secretion. Jour. Physiol., 34, 133, 1906.

[5] Komarov, S. A.: Gastrin. Proc. Soc. Exper. Biol. and Med., 38, No. 4, 514, 1937.

[6] Kosaka, T., and Lim, R. K. S.: Demonstration of Hormonal Agent in Fat Inhibition of Gastric Secretions. Proc. Soc. Exper. Biol. and Med., 27, 890, 1930.

[7] Ivy, A. C., and Gray, J. S.: Enterogastrone. Published in Cold Spring Harbor. Symposia on Quantitative Biology, 5, 405, 1937.

SURGICAL EMERGENCIES DURING CHILDHOOD CAUSED BY MECKEL'S DIVERTICULUM

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THE CONTRIBUTIONS to medical science distinguished by the name of Meckel were not all made by one man, as we are apt to assume, but by four men closely related to one another. Johann Frederick Meckel, the younger (1781–1833), belonged to the third generation of this remarkable family of anatomists. Among his contemporaries he was chiefly esteemed for a scholarly translation, from the Latin, of Wolff's monograph on the development of the intestines. To-day, we remember best his study of the pouch-like structure which not infrequently projects from the small intestine at a distance above the ileocecal valve, varying from 3 to 100 cm.

Meckel's diverticulum represents a remnant of the omphalomesenteric duct through which nourishment passes from the yolk sac to the embryo, in oviparous animals, like the chick.* In viviparous animals, such a need does not exist; and though present in the earliest stages of human development, the duct has no function to perform. Generally, the structure has vanished by the time of the child's birth, but not always. Whenever persistent, it becomes a menace to health.

Not only this intestinal pouch, but still other remnants of the omphalomesenteric duct occasionally plague their possessors. Malformations of that origin have been thought sufficiently important for classification as follows: (1) Pervious fistula running the full length of the duct. (2) Umbilical sinus. (3) Umbilical cyst. (4) Enterocystoma. (5) Fibrous cord attaching the umbilicus to the ileum. (6) Meckel's diverticulum.

The defect most often encountered is the diverticulum. At autopsy its incidence is roundly 2 per cent; and, oddly enough, it persists more often in the male sex. Thus, of the 19 patients in this report, 17 were boys and two were girls.

R. H. Fitz,[2] the pioneer American investigator of the clinical manifestations attributed to the vermiform appendix, took a deep interest in the comparable intestinal complications caused by Meckel's diverticulum. In the mature opinion of Fitz: "We owe to Meckel not only the almost universal acceptance of his theory of origin of the pouch in question, but also are indebted to him for calling conspicuous attention to its importance in the causation of serious disease."

Submitted for publication January 30, 1940.

* An admirable account of the embryology of the umbilical region will be found in Prof. Max Brodel's Chapter 1 of Cullen's Monograph on "The Umbilicus." Saunders, Philadelphia and London. 1916.

TABLE I

SYNOPSIS OF THE CLINICAL AND PATHOLOGIC DATA IN 19 CASES WITH MECKEL'S DIVERTICULA

Case	Sex	Age	Abd. Pain	Emesis	Melena	Hb. (Sahli)	W.B.C.	Duration of Symptoms	Postoperative Diagnosis	End-result
1	M.	8 yrs.	Yes	Yes	Yes	25%	6,700	7 days	Giant diverticulum; with perforating ulcer of ileum.	Recovery
2	M.	11 mos.	Yes	Yes	0	51%	25,350	14 hours	Diverticulum; with intra-abdominal hemorrhage.	Recovery
3	M.	2½ yrs.	Yes	Yes	Yes	52%	11,450	1 year	Diverticulum; with bleeding peptic ulcer of ileum.	Recovery
4	M.	6½ yrs.	Yes	0	Yes	36%	11,000	2 weeks	Diverticulum; with bleeding peptic ulcer of ileum.	Recovery
5	M.	6 mos.	0	0	Yes	32%	9,350	Intermittent 1 month	Diverticulum; with hemorrhage.	Death
6	M.	1 yr.	0	0	Yes	42%	14,200	Intermittent since age 3 months	Diverticulum; with hemorrhage.	Death
7	M.	7 wks.	?	Yes	0	56%	7,550	4 days	Acute intestinal obstruction caused by fibrous diverticulum.	Recovery
8	M.	5 yrs.	Yes	Yes	0	75%	15,300	24 hours	Acute intestinal obstruction caused by bands.	Recovery
9	M.	19 mos.	Yes	Yes	Yes	Not taken		30 hours	Acute intestinal obstruction caused by adhesions.	Death
10	M.	3 yrs.	Yes	Yes	0	82%	13,950	24 hours	Diverticulum causing acute intestinal obstruction.	Recovery
11	M.	5½ mos.	Yes	Yes	Yes	75%	16,950	10 hours	Diverticulum; with acute intussusception.	Recovery
12	F.	7 yrs.	Yes	Yes	0	75%	16,900	48 hours	Diverticulum; with acute intussusception.	Death
13	M.	11 mos.	Yes	Yes	Yes	71%	8,550	5 days	Diverticulum; with acute intussusception.	Recovery
14	F.	3 mos.	?	Yes	0	47%	22,000	48 hours	Volvulus.	Death
15	M.	17 hrs.	Abdominal distention			Not taken		Since birth	Prenatal gangrene of diverticulum; with peritonitis.	Death
16	M.	5½ yrs.	Yes	Yes	0	70%	16,600	20 hours	Diverticulitis; with perforation.	Recovery
17	M.	2½ yrs.	Yes	Yes	0	80%	6,000	4 days	Diverticulitis; with perforation.	Death
18	M.	11 mos.	0	0	0	46%	8,150	Since birth	Diverticulum; with umbilical fistula.	Recovery
19	M.	4 wks.	0	0	0	105%	12,500	Since birth	Diverticulum; with umbilical fecal fistula.	Recovery

Pathologic Anatomy.—The resection of a gigantic specimen, described in the first of the appended case reports, excited my interest in Meckel's diverticulum. Consequently, pertinent cases of my own, as well as those operated upon by my colleagues at the Children's Hospital, were collected. Together, they formed a series worthy of analysis.

The specimen just mentioned (Case 1), which measured 38½ inches in length, was longer than any of which we have found record. Moll[3] described

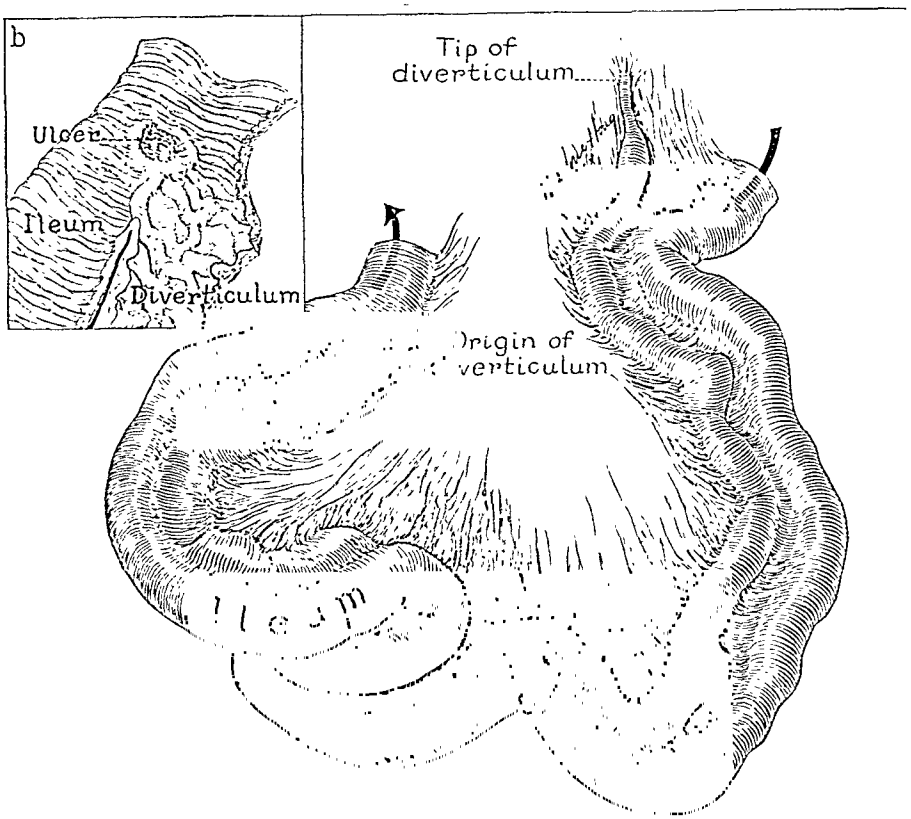


FIG. 1.—Case 1: Drawing of the giant diverticulum (duplex ileum) as it appeared at operation. It measured 38½ inches in length and was resected together with 37 inches of the adjacent ileum. Inset (b) shows the point of origin of the diverticulum and the large rugae of its mucosa, resembling, identically, those of the stomach mucosa, also the large perforating ulcer at the distal end of the resected ileum.

a diverticulum 33½ inches long in an infant five months old. Previously, Pollard[4] had reported a newborn with a diverticulum of 36 inches long that began 24 inches below the pylorus and ended as a huge culdesac in the umbilical cord. The term "duplex ileum" is applicable to a large intramesenteric diverticulum, such as the specimen of Moll, Pollard, and the one shown in Figures 1 and 1A.

True diverticula represent a continuation of the intestine, and their walls contain the same histologic structures as those of the intestine. *False diverticula,* on the contrary, do not possess a muscular coat. Utilizing this criterion, it has been established that intramesenteric diverticula belong to the true variety; yet, it is difficult to explain their peculiar location. Theories, to be sure, have been advanced to account for the transposition of the pouch; and,

because it is the most satisfactory, the hypothesis of Moll should be quoted. Initially in the embryo, he argues, the diverticulum always springs from the antimesenteric side of the intestine, and has a mesodiverticulum through which runs the vitelline (omphalomesenteric) artery. As involution proceeds to obliterate this blood vessel, it becomes shorter and shorter. Sometimes, Moll believes, the resultant traction draws the diverticulum upwards toward the border of the mesentery, tangential to the bowel. Then adhesions form, the previous vascular supply disappears, and a new one develops from arteries in the intestine. Furthermore, Moll assumes that long diverticula are caused by the premature withdrawal of the bowel away from the umbilical region, toward the peritoneal cavity.

The mucosa in the specimen in Case 1 was identical with gastric mucous

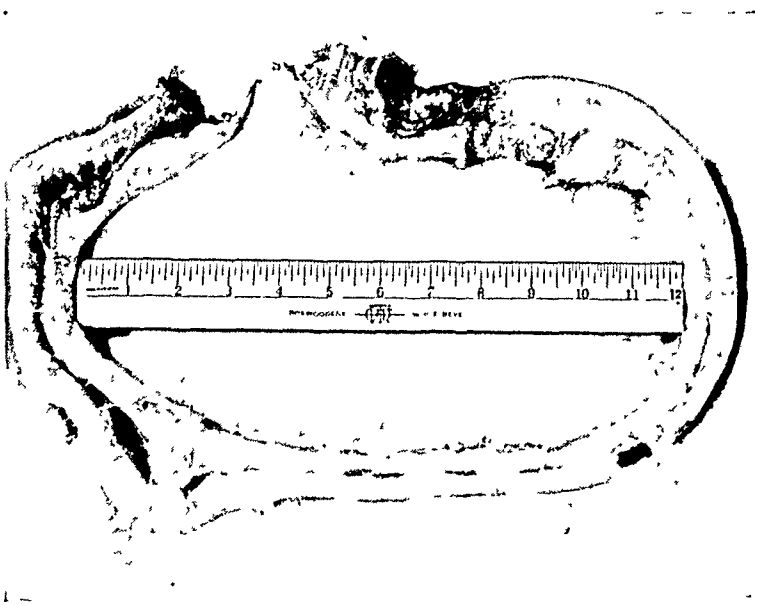


FIG 1 A.—Case 1: Photograph of the gross specimen of the resected diverticulum and the adjacent ileum.

membrane. In keeping with the observations of Curd[5] and others, the ulceration in this instance did not lie within the heterotopic gastric tissue, but in the adjacent ileum opposite the mouth of the diverticulum. Everyone agrees that lesions of this type are caused by the hydrochloric acid and pepsin which the heterotopic mucosa secretes. Ulceration, however, has been observed in diverticula where no trace of gastric mucosal histology was demonstrable.

No matter what their causation, ulcers may bleed, perforate, and initiate a peritonitis. Of exceptional interest is the case reported by Greenblatt, Pund and Chaney[6] in which a tumor of the diverticulum was mistaken for a duodenal ulcer, and after its removal the diverticulum was found to contain gastric mucosa, Brunner's glands, pancreatic tissue and a structure resembling a biliary duct. Other types of tumors, too, have been traced to the diverticulum;

Mathews[8] reported a malignant leiomyoma, Kadinsky, a "carcinoid" tumor, and Wisely, a medullary carcinoma.

The relative frequency of the familiar complications caused by Meckel's diverticulum is illustrated in the study of 201 cases by Miller and Wallace[7]: (1) Ulcers with hemorrhage, perforation, or both, occurred in 93 cases. (2) Intussusception in 63. (3) Other types of ileus in 26. (4) Acute inflammation in ten. (5) Miscellaneous complications in nine.

Our own, much smaller, series includes representatives of all these groups. Hemorrhage, which is always conspicuous in analytic reports of this kind,

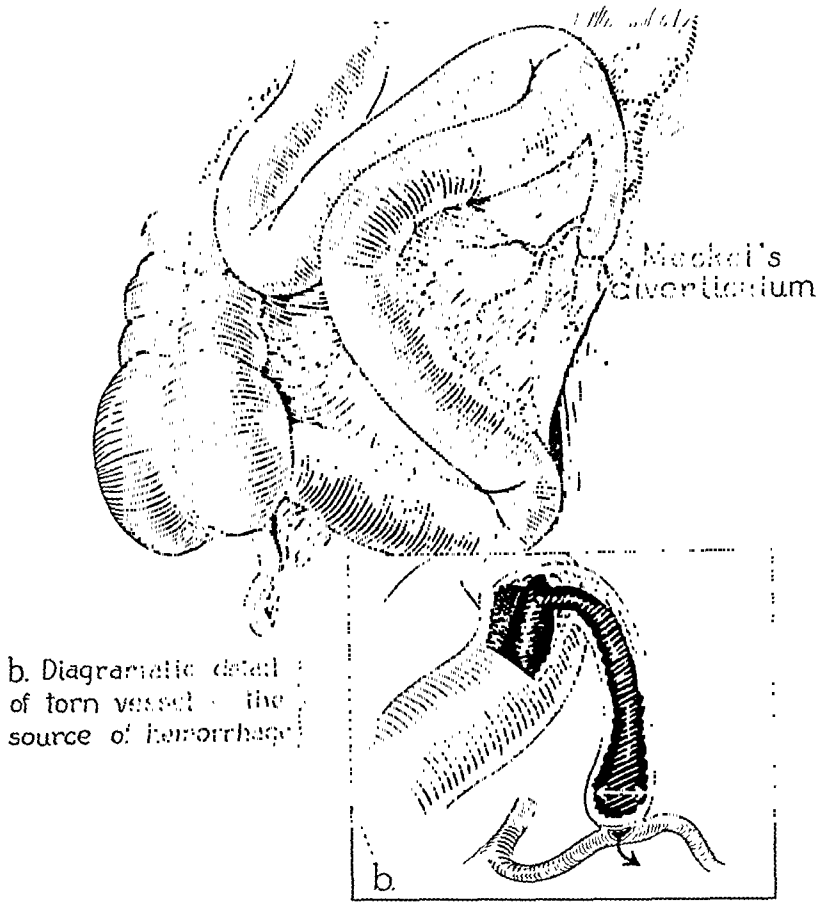


FIG. 2.—Case 2: Drawing showing a Meckel's diverticulum, the distal end of which had become adherent to the undersurface of the mesentery. Inset (b) shows, diagrammatically, the gross pathology at the site of its detachment, which resulted in the tearing of a blood vessel and consequent intra-abdominal hemorrhage.

had an unusual, if not unique, causation in Case 2. There, upon opening the abdomen, free blood escaped, and the terminal ileum was apparently full of blood. As the operation progressed, the distal end of the diverticulum was found located beneath the mesentery, pulled into a pocket where it had been fastened by adhesions. For some reason, unidentified, the adhesions had broken loose at one point, and a small mesenteric vessel had been torn across. A ligation of the vessel controlled the hemorrhage completely.

Harkins[9] estimated that intussusception accounted for 17 per cent of the complications attributable to Meckel's diverticulum. The complex character

of the mechanism at times is illustrated by Cases 11, 12 and 13. In Case 11, one foot of small intestine had telescoped into the ileum, and this, in turn, had passed through the ileocecal valve. The ascending colon also had telescoped into the transverse colon as far as the splenic flexure.

When a remnant of the omphalomesenteric duct provokes vovulus in a child, the prognosis is less favorable than with this type of ileus in an adult. A profound circulatory disturbance quickly leads to gangrene and peritonitis. The outlook is particularly serious if the twist has been initiated by a cord attaching the ileum to the umbilicus, to a viscus or to the mesentery. Death was the result of such a mechanism in Case 14.



FIG 3.—Case 5. Roentgenogram showing the presence of a Meckel's diverticulum

Of course, bands may cause obstruction other than volvulus. Thus in Cases 7 and 8, a segment of ileum had become obstructed at two different levels as it looped under a fibrous cord derived from a Meckel's diverticulum. In Case 7, the cord was attached to the convex surface of the ileum just above the higher level of obstruction, and passed over the intestine a second time near the ileocecal valve. Shortly after the band was cut, the intestine resumed its normal color.

Prenatal complications are exemplified in Case 15, where death, 17 hours after birth, was due to gangrene of the diverticulum. Boikan,[10] in making report of a similar situation, which he called "meconium peritonitis," has reviewed the literature on this subject.

The umbilical fistulae of Cases 18 and 19 are examples of one of the most interesting, but least common, complications. Embryologists have not been able to explain satisfactorily the rare finding, in Case 18, of gastric mucous membrane lining the umbilical end of the pouch and small intestine mucous membrane lining the ilial end (Fig. 5).

Other congenital defects, associated with cases in this series, were pyloric stenosis (Case 9), for which an operation had been previously performed; and mongolianism (Case 17). Christie[11] noted additional abnormalities in more than 30 per cent of his 63 cases of persistent diverticula.

COMMENT.—The vast majority of diverticula lie free in the peritoneal cavity and, therefore, give no inconvenience. Although a blind pouch, it seldom

entraps foreign bodies; through its wide mouth they have an easy exit into the lumen of the bowel. In this respect the diverticulum differs from the appendix but, like the appendix, it frequently becomes the seat of an inflammatory process; and the resulting symptoms are so much alike, in both instances, that they may rarely be distinguished. In Case 6 chronic diverticulitis was mistaken for appendicitis.

Nearly always, the prevalent symptoms arise from one of the various complications to which the diverticulum is subject. Thus, it has been found among the contents of a hernial sac—inguinal, femoral or umbilical. Symptoms at other times are referable to the ulceration; bleeding and perforation have already been discussed. Likewise, in the section on pathologic anatomy, the intimate relationship between the diverticulum and intestinal obstruction was

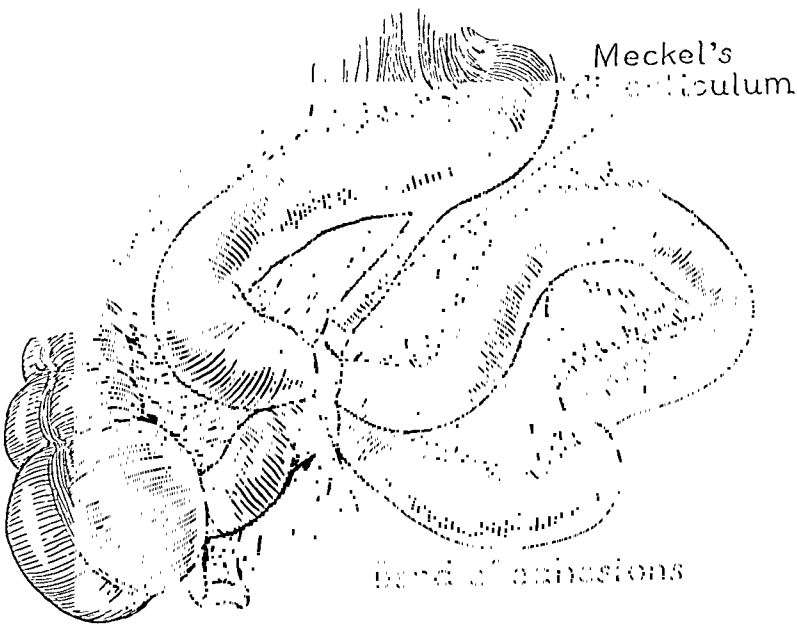


FIG. 4.—Case 7: Drawing showing the operative pathology in this instance of Meckel's diverticulum, the fibrous tip of which had become attached to the root of the mesentery resulting in the obstruction of the terminal ileum at two levels.

considered, and it follows that frequently symptoms of ileus alone are present when, in reality, a persistent diverticulum is the root of the trouble.

So variable, indeed, are the complications in question, that, whenever the surgeon is called upon to treat an abdominal emergency, especially during childhood, the preliminary diagnosis should take into account a persistent diverticulum as the basic factor in the problem; and, at the time of operation, exploration should always establish the presence or absence of this structure.

The clinical manifestations, never specific, merely point to a severe disturbance somewhere within the abdomen, which becomes distended and exhibits muscular rigidity either locally or generally. Most significant among the subjective symptoms are pain, nausea and vomiting, sometimes constipation, more often small evacuations containing blood. The laboratory findings may indicate an anemia (hemoglobin in this series varied from 25 to 105 per

cent) or an infection (leukocytes varied from 6,000 to 25,000); but, on the whole, the blood picture proves to be helpful in diagnosis only when integrated with the facts gathered from the history and physical examination of the patient. Radiography has a very limited usefulness. In Case 5, to be sure,

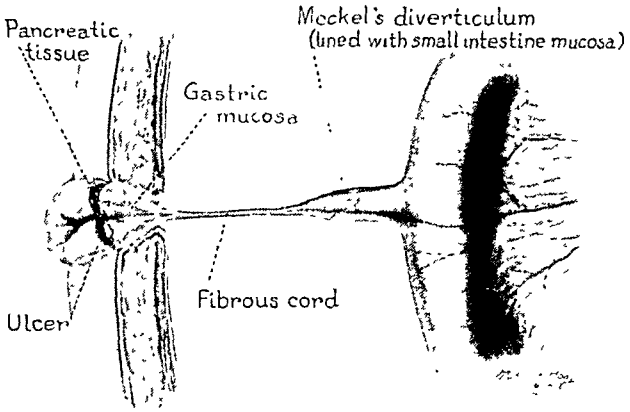


FIG. 5.—Case 18: Drawing showing the operative pathology of an umbilical sinus which connected with a Meckel's diverticulum.

the correct diagnosis was made by the roentgenologist, yet this experience suggested nothing in the way of a principle capable of wide application.

The period of time elapsing between the onset of symptoms and the requisite surgical operation, varied from a few hours to several years in this series of cases. A review of the records demonstrates, as could be predicted, that the duration of the illness and the efficacy of surgery have a direct re-

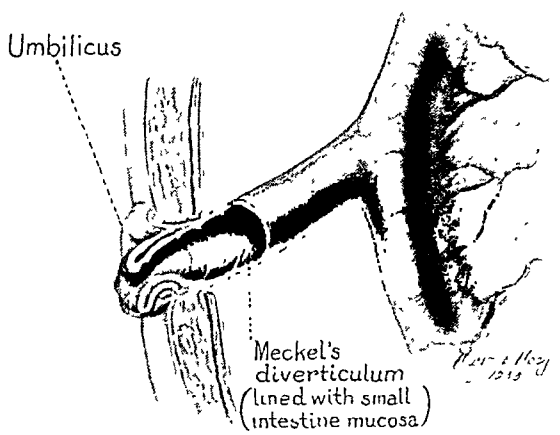


FIG. 6.—Case 19: Drawing showing the operative pathology in an instance of an umbilical fecal fistula which connected with a Meckel's diverticulum.

lationship. Early diagnosis promotes a smooth convalescence and recovery. But, technical factors also enter largely into the character of the results the surgeon obtains. Anyone who has merely seen a diverticulum of the usual

type at autopsy or a chance finding during a celiotomy will be impressed with its resemblance to the vermiform appendix; and he may assume that the removal of either structure should be equally simple. That conclusion, however, overlooks the fact that, usually, multiple pathology must be treated when a diverticulum becomes the indication for an operation.

And, besides, the technic of appendicectomy differs notably from that of removal of a diverticulum, even when the underlying pathology consists of nothing more than an acute inflammation. Hudson[12] has correctly emphasized the risks, especially in children, of inverting a diverticulum stump with a purse string suture. Too often, as in Case 6, edema and occlusion of the bowel cause death. To avert that result, the aperture in the intestinal wall after removal of a diverticulum should be closed in layers, transverse to the long axis of the bowel, just as after the intestine has been opened to remove a polyp or a foreign body.

Mortality.—Among the 19 cases in this series, there were seven deaths, a mortality of approximately 37 per cent. The youngest patient was a newborn infant, the oldest a child of eight years. The ages of these children increased the surgical hazards, especially since some of the operations were performed before present-day facilities became available to combat under-nourishment, hemorrhage, acidosis and dehydration.

SUMMARY AND CONCLUSIONS

The analysis of 19 celiotomies upon children, occasioned by persistent Meckel's diverticula, includes the description of a specimen, longer than any previously reported—a "duplex ileum." Other cases illustrate the familiar complications attributable to this vestigial structure—hemorrhage, ulceration, perforation, peritonitis, intussusception, volvulus, intestinal obstruction, umbilical sinus, and umbilical fecal fistula. Gangrene in one instance occurred during intra-uterine life, so-called "meconium peritonitis."

The surgeon should never overlook a diverticulum as the possible source of the trouble whenever he is called upon to treat an acute abdominal emergency during childhood. In abdominal section for acute intestinal obstruction, where symptoms do not call for exploration of a particular portion, the incision should be made in the right lower quadrant. The region of the umbilicus and the terminal three feet of the ileum should receive first attention. If a band is found, it is most likely the remains of a persistent vitelline duct or an omphalomesenteric vessel. The pediatrician must also bear this diagnosis in mind when faced with cases of indefinite abdominal pain accompanied by periodic mild anemia and low grade, unexplained fever.

The postoperative result was recovery in 12, and death in seven cases. Inversion of the stump with a purse string suture, responsible for one fatality, is a hazardous procedure in children, because subsequent edema may completely block the lumen of the intestine. Only by early operation, can a satisfactory mortality rate be obtained.

REFERENCES

[1] Meckel, J. F.: Über Die Divertikel am Darmkanal. Arch. f. d. Physiol., 9, 421, 1809.

[2] Fitz, R. H.: Persistent Omphalomesenteric Remains: Their Importance in the Causation of Intestinal Duplication, Cyst Formation, and Obstruction. Amer. Jour. Med. Sci., 88, 30, 1884.

[3] Moll, R. H.: Giant Meckel's Diverticulum. Brit. Jour. Surg., 14, 176, 1926.

[4] Pollard: Quoted by Moll.[3]

[5] Curd, H. H.: Histologic Study of Meckel's Diverticulum with Special Reference to Heterotopic Tissues. Arch. Surg., 32, 506, 1936.

[6] Greenblatt, R. B., Pund, E. R., and Chaney, R. H.: Meckel's Diverticulum—An Analysis of 18 Cases with Report of One Tumor. Am. Jour. Surg., 31, 285, 1936.

[7] Miller, R. H., and Wallace, R. H.: Meckel's Diverticulum in Acute Abdominal Emergencies. ANNALS OF SURGERY, 98, 713, 1933.

[8] Mathews, F. S.: Meckel's Diverticulum—A Report of 12 Cases Including One Tumor. Arch. Surg., 10, 720, 1925.

[9] Harkins, H. N.: Intussusception Due to Invaginated Meckel's Diverticulum—Report of 2 Cases with a Study of 160 Cases Collected from the Literature. ANNALS OF SURGERY, 98, 1070, 1933.

[10] Boikan, W. S.: Meconium Peritonitis. Arch. Path., 14, 50, 1932.

[11] Christie, Amos: Meckel's Diverticulum—A Pathologic Study of 63 Cases. Am. Jour. Dis. Child., 42, 544, 1931.

[12] Hudson, H. W., Jr.: Meckel's Diverticulum in Children. New Eng. Jour. Med., 208, 525, 1933.

ACUTE THROMBOCYTOPENIC PURPURA HEMORRHAGICA ASSOCIATED WITH TUBERCULOSIS (MILIARY) OF THE SPLEEN

SPLENECTOMY—RECOVERY

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WINTERNITZ,[1] in 1912, advanced the opinion that primary tuberculosis of the spleen may not mean that the spleen is the portal of entry of the organism, or the first tissue of the body in which the disease manifests itself, but that the tuberculous process may localize itself in the spleen which acts as a focus for dissemination of the tubercle bacilli, and that the original focus may remain entirely quiescent. In a careful analysis of 51 cases of tuberculosis of the spleen, he found two instances in which the skin showed evidences of purpura or ecchymosis.

The case of miliary tuberculosis of the spleen, herewith reported, showed no tuberculous lesions arrested or active in any other part of the body, and would very appropriately be placed in the classification of Winternitz's primary tuberculosis of the spleen. Another salient feature in this case was the fulminating character of the blood platelet disappearance, and their rapid reappearance following splenectomy. In view of the fact that the spleen was the only organ showing manifestations of miliary tuberculosis, the casual relation that miliary tuberculosis of the spleen appears to bear to acute thrombopenic purpura hemorrhagica is demonstrated by this case.

Purpuric diatheses, in association with tuberculosis, has been described in adults, and many pathologists have felt that the purpura was secondary to a toxemia. Bauch,[2] in 1916, reported three instances of purpura in adults with pulmonary tuberculosis, and his opinion was that the tubercle bacilli, or their toxins, acted as irritants to the endothelium of the cutaneous vessels and produced the hemorrhagic or purpuric spots. Another theory that Bauch has advanced is that the blood vessels may have undergone hyaline or amyloid changes with the resultant purpuric manifestations. Garin,[3] in 1920, in reviewing 26 cases, felt that the hemorrhagic purpura was secondary to the tuberculosis. Pratsicas,[4] in 1924, reported four cases, all of whom were found to have enlarged spleens, and in each instance exhibited purpuric manifestations—all cases came to autopsy. The ages given in three of the cases were 22, 22 and 23, respectively. Pratsicas believed that in two cases the cutaneous hemorrhages were embolic and in the third case the result of disseminated miliary tuberculosis. Villa,[5] in 1928, reported a singular observation in a female,

Submitted for publication September 13, 1939.

age 38, who, after being confined to the hospital for two weeks, began to bleed from the gums, developed epistaxis, hematuria and melena, purpura on the body, and had an enlarged spleen and a reduced platelet count. The patient died five days after the purpuric manifestations appeared. Autopsy revealed evidences of miliary tuberculosis. Winternitz specifically states that all cases of tuberculosis of the spleen not operated upon died. Fifty-nine per cent of the cases who had splenectomies performed, survived. Kellert,[6] in 1931, reports a case of miliary tuberculosis of the spleen associated with thrombopenic purpura, in which instance the spleen was removed and the patient recovered. This was similar to the case herewith reported, except for the lesion of the lung. Andrus and Holman,[7] in 1939, reported 12 cases of thrombocytopenic purpura that recovered from the blood disorder following splenectomy. The case herewith reported, of miliary tuberculosis of the spleen with a fulminating thrombocytopenic purpura, also made a complete recovery following splenectomy.

Case Report.—Hosp No. V-6709: C B., male, age 42, was admitted to the Gouverneur Hospital, April 28, 1938, complaining of epistaxis and ecchymosis of the skin, of three days' duration. His mother died from hypertension, otherwise the family history was irrelevant. He had had the usual childhood diseases. He had been operated upon for glaucoma, at the age of nine; and had had an hemorrhoidectomy performed nine years ago. Negative venereal history.

The patient had been perfectly well until April 19, 1938 (three days prior to admission), when he noticed large blotches on his right arm He was suddenly awakened the same night by what the patient described as "a sensation of feeling bloody pimples

LABORATORY DATA

	Preoperative		Postoperative			
	4/22/38	4/24	4/27	4/28	5/3	5/15
W B C	10,000	6,700				9,800
Polys	64	63%				68%
Lymph	36	26%				32%
Monocytes	0	8%				
Eosin	0	3%				
Platelets	40,000	5,000	200,000	300,000	500,000	500,000
R B C	5,200,000	5,420,000	4,400,000		3,900,000	4,000,000
Hb	126%	100%	82%		78%	85%
Bleeding time	10 min.	10 min	2 min			
Coagulation time	2½ min					

4/22		4/25	
Pinch and tourniquet tests were positive		Blood sugar	101 mg
Fragility test: Maximum resistance	0 44%	N P N	34 mg
Minimum resistance	0 32%	Wassermann	negative

Urine Examinations

4/22	Benzidine	4 plus
	Albumin	2 plus
4/25	Benzidine	4 plus
	Albumin	2 plus
4/29	Benzidine	1 plus
	Albumin	trace
5/5	Benzidine	negative
	Albumin	negative

on his lips and mouth." The following morning he had a nose bleed, and black and blue as well as red spots appeared over his entire body. His condition became rapidly worse, and he complained of a tight sensation (pressure) over his entire head, and weakness. Just before admission to the hospital, he noticed that his urine was bloody.

Physical Examination.—Patient is acutely ill; hemic component good. Eyes: Right, cataract; left, previous glaucoma operation. Nose: Bloody crusts in right nasal passage. Mouth: Small ecchymotic spots present on lips, soft and hard palate and tongue. Neck: No adenopathy noted. Heart and lungs: Negative. Abdomen: Soft. No tumor mass palpable. Liver and spleen not enlarged. Neurologic status: Normal. Rectal examination: Negative. Skin: Large, painless ecchymotic areas over upper extremities and on right great toe. Smaller areas present over entire body—more purpuric than ecchymotic. Blood pressure preoperatively was 115–120/80. Postoperatively 118–132/80. Roentgenologic examination of the chest was negative for tuberculosis. *Diagnosis:* Acute thrombocytopenic purpura hemorrhagica.

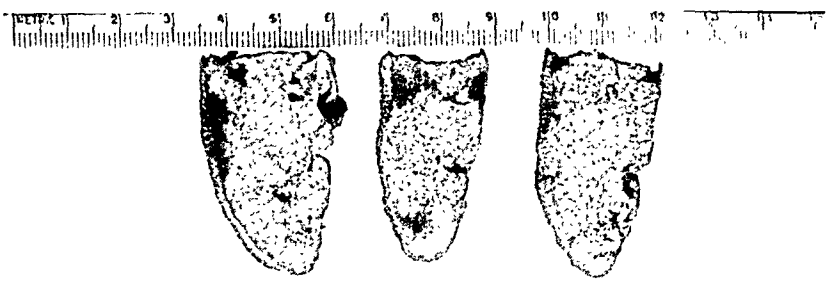


FIG. 1.—*Gross Pathology of Spleen:* The viscus measured 14x9x4 cm. and weighed 237 grams. The surface was smooth except in one area where there was a fibrous thickening about 1 cm. wide. The hilus appears normal. On section, the spleen cuts with resistance, and throughout there appears to be marked hyperplasia of the lymphatic structures. Nodules varying in size from 1 Mm. to 1 cm. are seen, many are confluent. No necrotic or caseous areas were found. The capsule appeared to be normal.

Recommendation.—(1) Conservative and expectant—which may lead to a remission of the acute stage. However, the danger in the method is the possibility of a cerebral hemorrhage or hemorrhage into some other vital organ. (2) Splenectomy—which is curative in majority of the cases, which latter was elected.

Operation.—April 26, 1938. Dr. Rupert F. Carter: Routine splenectomy. Convalescence was normal. Patient received 400 cc. of blood on the day of the operation, 300 cc. on April 27, 1938, and 350 cc. April 29, 1938.

Pathologic Examination.—Gross: Path. No. 4114. Drs. M. Kopel and D. Symmers: The spleen measured 14x9x4 cm. and weighed 237 grams. The surface was smooth except in one area where there was a fibrous thickening about 1 cm. wide. The hilus appeared normal. On section, the spleen cut with resistance, and throughout there appeared to be marked hyperplasia of the lymphatic structures. Nodules varying in size from 1 Mm. to 1 cm. were noted, many confluent. No necrotic or caseous areas were found. The capsule appeared to be normal (Fig. 1).

Microscopically, the capsule and trabeculae appeared thickened and fibrous; pulp congested with red cells; sinuses dilated; malpighian corpuscles hyperplastic; central arteries of the malpighian corpuscles thickened (Fig. 2). *Pathologic Diagnosis:* Miliary tuberculosis of the spleen.

Follow-Up Record.—Readmitted, April 11, 1939, for check-up examination. The patient had gained weight; general condition good; no complaint; feels well. A roentgenogram of the chest showed the heart slightly enlarged to the left. Slight accentuation of the aorta. Hilus markings increased. Lungs: Increased pulmonic markings throughout. Interlobar pleura is visualized. Diaphragm normal. Costophrenic spaces

clear. *Follow-Up Conclusions:* Slightly enlarged heart. Secondary congestive lung changes.

Laboratory Data.—Amount of urine in 24 hours—1,100 cc. Vitamin C in 24-hour urine—34.1 mg. Vitamin C in 100 cc. of urine—3.1 mg. Stool—negative. Sputum—negative for tubercle bacilli. Sediment rate—nine millimeters in one hour.

Blood Examination.—April 20, 1939: Hemoglobin 96 per cent; R.B.C. 5,070,000; W.B.C. 9,400; nonsegmented polys. 5; segmented polys. 28; eosinophiles 3; basophiles 1; lymphocytes 52; monocytes 12; platelets 320,000.

The platelet count is normal. Relative lymphocytosis and mononucleosis is what one would expect to find in a patient who has had a splenectomy for miliary tuberculosis.



FIG. 2.—Photomicrograph showing, scattered throughout the spleen, numerous centrally pink-stained tubercles, surrounded by epithelioid cells accompanied by Langhan's giant cells. Some of these are surrounded by a wall of lymphocytes, others by a thin fibrous tissue capsule. Diagnosis: Miliary tuberculosis of the spleen.

Montoux test: Right forearm (1/1,000)—24 hours—1 plus; 48 hours—1 plus. Bleeding time—3 min., 10 sec. Coagulation time—4 min., 20 sec.

Fragility test (Rumpel-Leed): Four petechial areas in area three inches below tourniquet (normal manifestation). R.B.C. fragility hemolysis begins at 0.40 per cent and ends at 0.28 per cent—indicating decreased fragility (normal fragility 0.34 to 0.44).

SUMMARY

(1) A case of tuberculosis of the spleen (with miliary tubercles) associated with acute thrombopenic purpura is presented.

(2) Splenectomy was followed by complete recovery.

(3) A check-up blood examination, one year later, revealed a normal platelet count and a relative lymphocytosis.

(4) The general condition of the patient is good, and he has gained 40 pounds during the past year.

REFERENCES

[1] Winternitz, M. C.: Tuberculosis of the Spleen. Arch. Int. Med., 9, No. 6, 680–697, June, 1912.

[2] Bauch, S.: Three Cases of Purpura Hemorrhagica in Chronic Tuberculosis. Arch. Int. Med., 17, No. 3, 444, March, 1916.

[3] Garin, G.: Hemorrhagic Purpura and Tuberculosis. Riforma Med., 36, 952, October, 1920; abstr. J.A.M.A., 76, 276, January 22, 1921.

[4] Pratsicas, A.: Relation of Miliary Tuberculosis with Purpura Hemorrhagica. Rev. de la tuberc., Paris, 5, 642–657, October, 1924.

[5] Villa, L.: Orientations about the Study of Secondary Tuberculous Purpura Hemorrhagica. Riv. di. pat. e. clin. d. tuberc., Bologna, 2, 241–263, April 30, 1928.

[6] Kellert, E.: Miliary Tuberculosis of the Spleen with Thrombopenic Purpura Hemorrhagica. J.A.M.A., 96, No. 26, 2193–2194, June 30, 1931.

[7] Andrus, W. DeW., and Holman, C. W.: Splenectomy in Various Blood Disorders. ANNALS OF SURGERY, 109, 64–83, January, 1939.

THE USE OF ERGOTOXINE AND ERGOTAMINE IN THE SURGICAL MANAGEMENT OF THYROTOXICOSIS*

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ELLIOT,[1] in 1904, postulated that adrenalin mimicked the action of the sympathetic nerves, and even suggested that adrenalin might act as the intermediate agent between nerve ending and the organ. This conception later received much support and was greatly enlarged by the contributions of Loewi,[2,3] Dale,[4,5,6,7] and many others.

In 1906, Dale[8] first showed the capacity for ergot preparations to abolish this sympathetic effect. In other words, ergot preparations have the quality of *preventing the action of adrenalin.* According to Barger,[9] the preparation used by Dale was chrysotoxin, which contained 2 per cent of ergotoxine, and this latter is undoubtedly the effective substance. The isolation of ergotoxine by Barger and Carr,[10] the same year, made possible a more precise and efficient application of this principle, and this was further supplemented by the discovery of ergotamine, in 1920, by Stoll.[11] Ergotoxine and ergotamine have similar pharmacologic actions (Clark[12]).

In 1927, Navratil[13] showed that stimulation of an accelerator nerve of an ergotaminized heart still results in the production of the accelerating substance, adrenalin, but it does not show the usual action upon the heart. This might be interpreted by considering that ergotamine occupies certain pattern-cell receptors, thereby preventing the adsorption of adrenalin on these same receptors so that no accelerating effect can take place.

The pharmacologic literature concerning the ergot alkaloids is unusually extensive and well known, but any clinical application finds rather uncertain support from the frequently confusing and sometimes conflicting contributions. The observations reported in this investigation bring definite clinical evidence regarding the ergotoxine-ergotamine-adrenalin relationship. One of the most distressing phenomena in the surgical management of thyrotoxicosis is the associated tachycardia. This fact is so well known among surgeons that any further discussion would be superfluous. However, a study of the operative and postoperative periods of patients subjected to thyroidectomy offers ample evidence to confirm this clinical experience. In an effort to minimize this cardiac reaction to surgery the following rationale was evolved which

* An abstract of this paper was read before the American Society for Pharmacology and Experimental Therapeutics, Toronto, Ontaria, April, 1939.

Submitted for publication August 4, 1939.

led to the use of ergotoxine and ergotamine in a series of cases of thyroidectomies for thyrotoxicosis.

In the surgical treatment of thyrotoxicosis there are two periods during which tachycardia becomes a most serious and alarming manifestation: (1) During operation. (2) Twenty-four to 72 hours postoperatively—the period of so-called crises.

The tachycardia occurring during operation is not susceptible of explanation on the basis of thyroxin activity alone, because thyroxin effects ought not to appear for at least 12 hours, and usually are evident only after 24 to 36 hours. This tachycardia, then, would seem best explained by an increased output of adrenalin as a result of the subjective sensations of anxiety, fear, *etc.*, and those objective considerations of trauma, blood loss, anoxia, *etc.* This excess would have the most pronounced effect upon the cardiac rate because thyroxin specifically potentiates the action of adrenalin on the specific tissue or the myocardium.

On the other hand, the tachycardia occurring during the crises might very properly be explained upon the basis of a thyroxin effect because of its operative release 24 to 72 hours previously, and the potentiation of a relatively normal adrenalin production. Therefore, in the operative reaction, adrenalin is a major factor and thyroxin a minor one, while in the crises, thyroxin is the major factor and adrenalin the minor one.

Accordingly, the operative tachycardia should be susceptible to more efficient control by ergotoxine and ergotamine than that of the postoperative period—this has been found to be the case. Incidentally, in the cases presented, ergotoxine and ergotamine had no effect on the anoxic tachycardia, and they illustrate rather clearly the high value, in fact, the necessity for a supplemental oxygen supply in postoperative cases of thyrotoxicosis. The last 15 consecutive cases of thyrotoxicosis observed form the basis of this report and the response obtained was interpreted as favorable in all instances. The details of five cases are herewith presented to illustrate the different reactions encountered during this investigation, and to exemplify the experiences with the cases thus far observed.

CASE REPORTS

Case 1.—Met. No. 966: L. D., white, female, age 56, was admitted to the Metropolitan Hospital, January 23, 1939, with a basal metabolic rate of plus 53, and a pulse rate of 118. Under iodine therapy and usual preoperative regimen the pulse rate gradually fell; on February, the basal metabolic rate was plus 40, on the seventh, plus 36, and on the ninth, plus 19.

Under cyclopropane anesthesia, operation was begun at 9:20 A.M., February 14. At 10:35 A.M. the pulse rate had risen to 120 and ¼ mg. ergotamine was administered. Operation was completed at 11:00 A.M., and the pulse rate had fallen to 96.

The next morning, at 9:00 A.M., the temperature was 106° F., and the pulse rate 110. The next afternoon, at 5:00 P.M., the temperature was 105.4° F., and the pulse rate 120. That evening, at 10:00 P.M., the temperature was 105.4° F., and the pulse rate 110. In view of these temperatures, the pulse rate remained relatively low (Chart 1). This pulse stability is probably related to three spaced doses of ergotamine during this time.

This case illustrates fair operative and good postoperative control of the pulse rate by ergotamine.

Case 2.—Hosp. No. 7681: A. O'L., white, female, age 48, was admitted to the Flower-Fifth Avenue Hospital, November 15, 1938, with a one-month history of illness. Exophthalmos was present; the basal metabolic rate before admission was plus 70 and the pulse rate 120. Under iodine therapy and usual preoperative regimen the pulse rate varied between 120 and 134 during the first week. On November 23, the basal

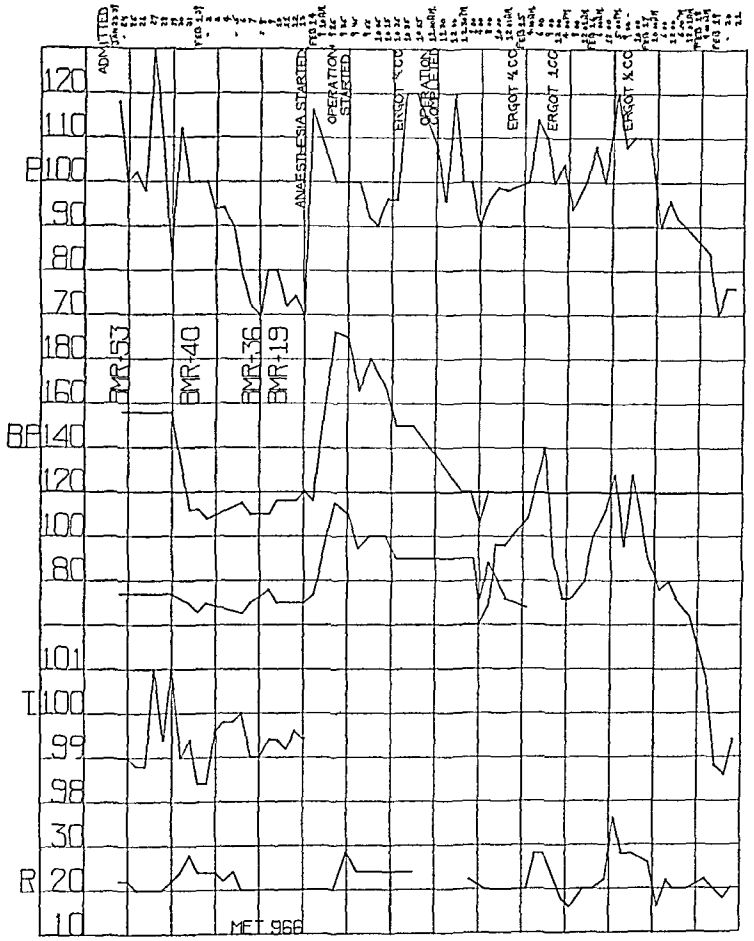


CHART 1.—Met. Hosp. No. 966: Shows rather good operative and postoperative control of pulse rate by ergotamine.

metabolic rate was plus 46. The pulse rate gradually became slower, to remain within the 90–100 division; on December 2, the basal metabolic rate was plus 21, on December 6, plus 20. The pulse rate was unstable most of the time.

On December 7, anesthesia with cyclopropane was begun at 2:18 P.M., when a high initial pulse rate appeared but which immediately came down on induction of anesthesia. At 2:42 P.M., the pulse rate had risen to 120, and ¼ mg. ergotamine was administered. In ten minutes the pulse rate was 108 and remained relatively well controlled and stabilized until operation was completed, at 3:45 P.M. At 3:55 P.M., the airway was removed and the pulse rose to 120 and remained in this vicinity for 48 hours.

This persistent high pulse level remained on an even plateau until the intro-

duction of intranasal oxygen, 48 hours later. This supplemental supply of oxygen resulted in a fall in pulse rate to 100 and then to 84, with a temporary rise when the oxygen was discontinued (Chart 2). The pulse rate during this 48-hour period was high but well stabilized, and the stability was attributed to four doses of ergotamine during this time, while the tachycardia would appear to be due to anoxia.

This patient illustrated singularly well the fact that ergotamine (or ergotoxine) had no effect on the tachycardia of anoxia, and that by this therapy

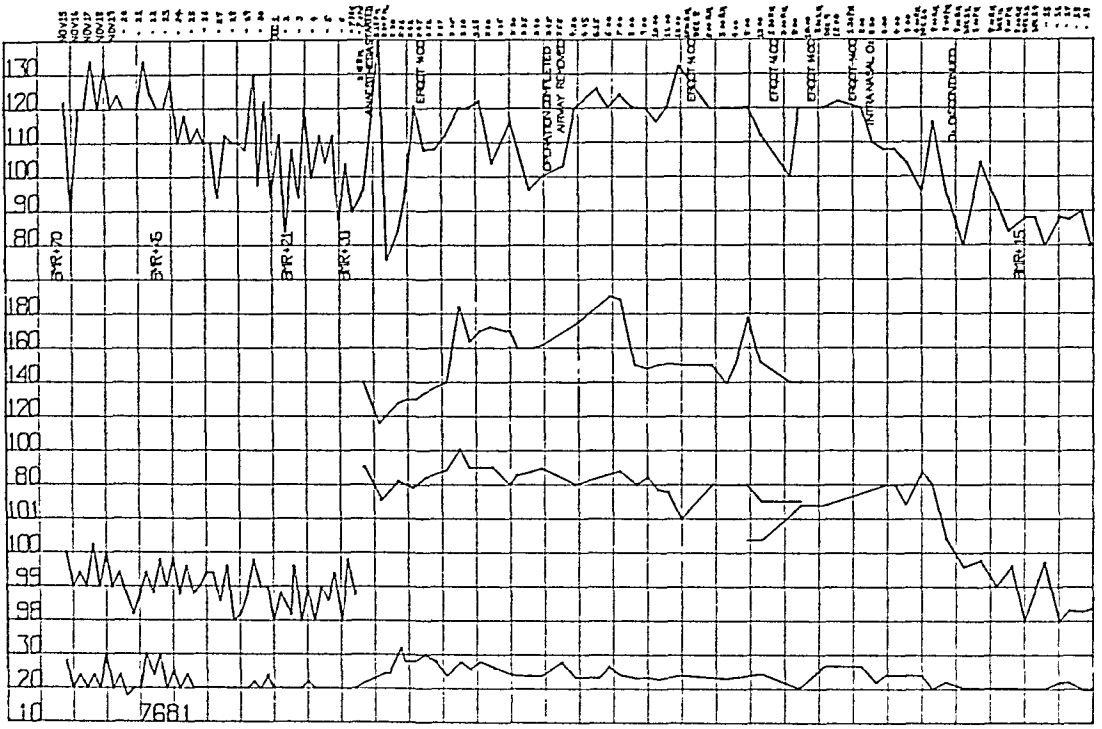


CHART 2.—Hosp. No. 7681: Shows marked pulse instability preoperatively, and relatively good postoperative stability after five doses of ergotamine. Also, on removal of the airway, pulse rate rose remaining to a relatively level plateau until the administration of intranasal oxygen, 48 hours later. This shows that an anoxic pulse is not effected by ergotamine.

the operative and postoperative pulse is more stable and better controlled than that of the preoperative period.

Case 3.—Hosp. No. 1514: B. T., white, female, age 40, was admitted to the Flower-Fifth Avenue Hospital, March 5, 1939, with a two-month history. There had been no exophthalmos but the basal metabolic rate was plus 60 on January 25, 1939. The symptoms entirely subsided under iodine therapy. She remained quite well for a few weeks but soon became worse. On March 7, the basal metabolic rate was plus 25, on March 15, plus 36.

Her pulse rate was unstable during this period and gradually increased in rate. Her condition did not improve with iodine therapy and operation was performed, April 1, 1939. The operation started at 10:18 A.M. (cyclopropane anesthesia), with an initial pulse rate of 90. At 10:55 A.M., the pulse rate had climbed to 154 when ½ mg. ergotamine was administered. Sixteen minutes later the pulse was 90. The pulse remained relatively well controlled, fluctuating between 105 and 130; at 12:44 P.M. the ergotamine was repeated. The operation was completed at 12:53 P.M., having required two hours, 35 minutes.

For some time the pulse rate did not exceed 120. Ergotamine (¼ mg.) was given

at 6:00 that evening and again at midnight. However, the next morning at 6:00 A.M. the pulse had risen to 160. Ergotamine was given again, but no definite effect was observed; at 7:30 A.M. the pulse rate had risen to 176 and the temperature to 105° F. Those in

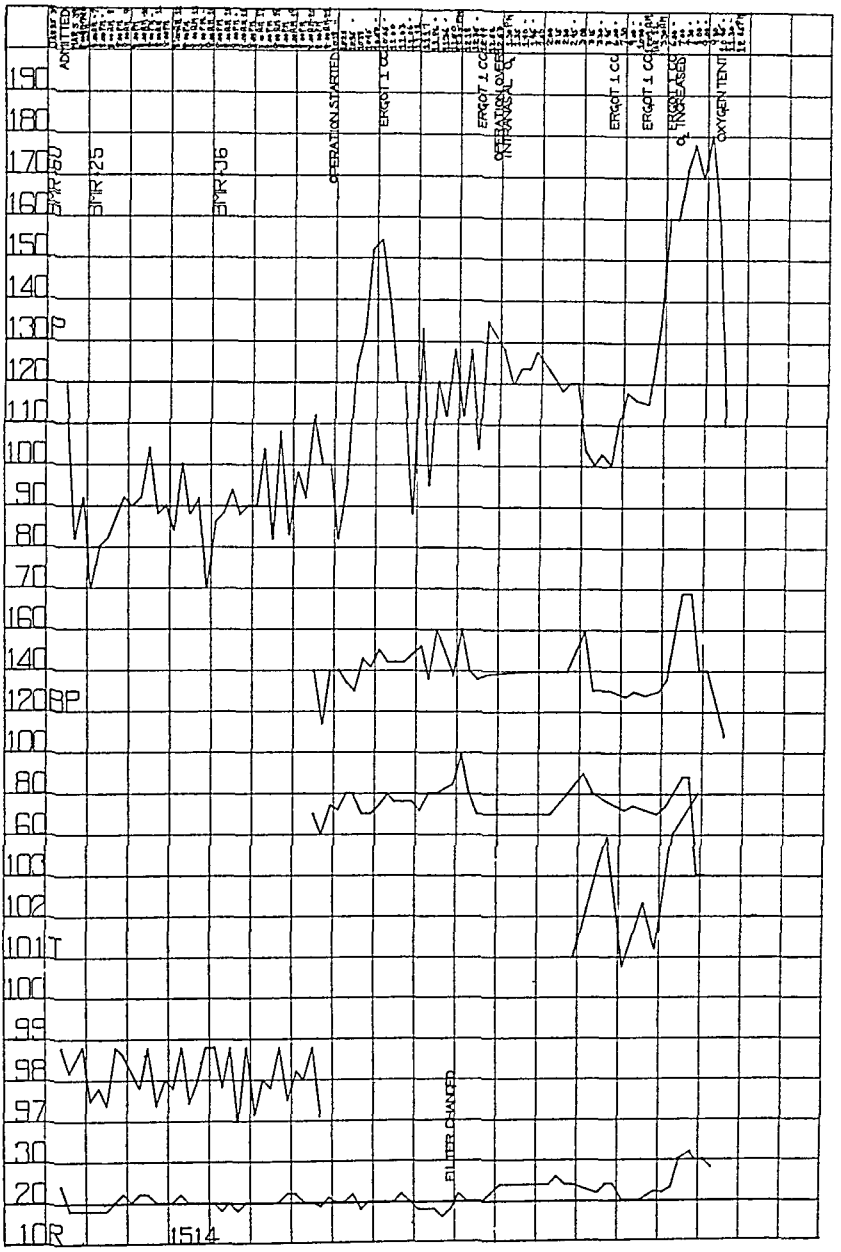


CHART 3.—*Hosp. No. 1,514: Shows marked pulse instability before operation, with an increasing rate, a high operative peak, well controlled by ergotamine, and, in view of the severity of the reaction, a relatively good postoperative control. Near the end of the first 24 hours, anoxic symptoms developed and exitus took place, probably due to some respiratory accident.*

attendance felt that this was undoubtedly, at least in part, a reaction to a mechanical anoxia; despite attempt at increasing oxygen supply, the patient expired about 1:00 P.M. (Chart 3).

Notwithstanding the unfortunate outcome of this case, ergotamine seems to have exerted a very definite control of the operative tachycardia and even the postoperative reaction until evidences of anoxia became very pronounced.

Case 4.—Met. No. 1189: M. D., white, female, age 62, was admitted to the Metropolitan Hospital, January 27, 1939. On February 6, the basal metabolic rate was plus 51. Under iodine therapy and the usual preoperative regimen the basal metabolic rate fell to plus 23 by February 20; during this intervening period the pulse rate fluctuated between 108 and 80.

Operation was begun at 9:00 A.M., February 21, and at 9:50 A.M., the pulse rate had risen to 126, so that ¼ mg. ergotamine was administered; at 10:00 A.M., the pulse was 90, remaining relatively well controlled until the operation was completed at 10:20 A.M.

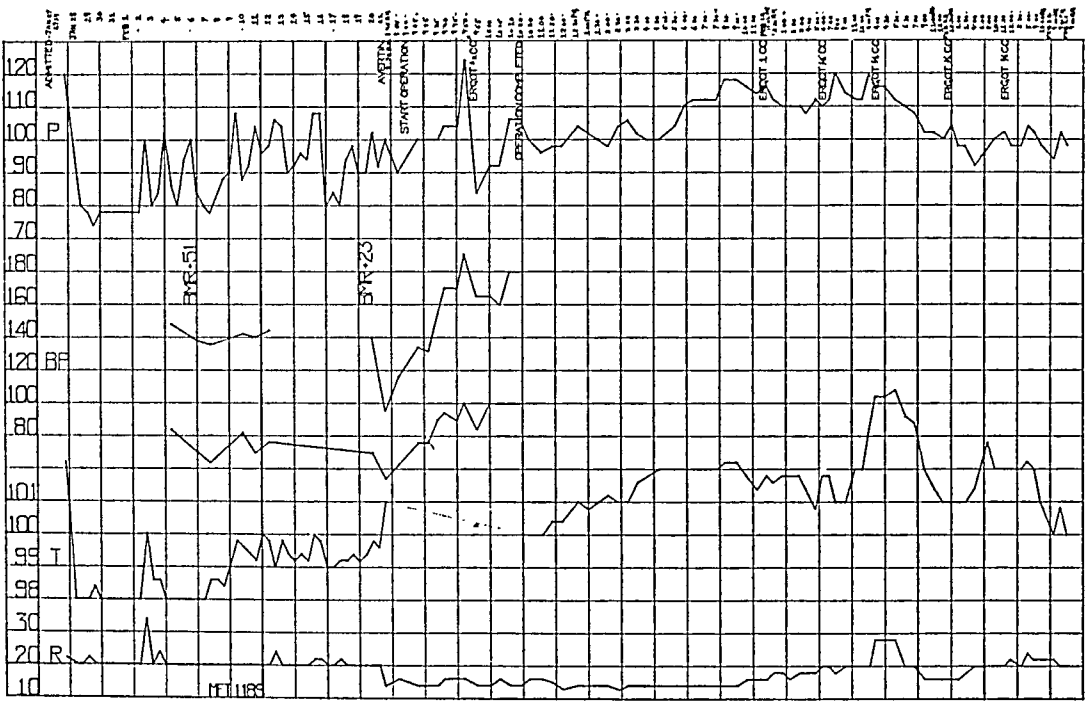


CHART 4.—Met. Hosp. No. 1,189: Shows control of the peak pulse rise during operation, and a relatively level postoperative plateau, after five doses of ergotamine. The pulse plateau, postoperatively, stands in marked contrast to its preoperative instability.

The patient received ½ mg. ergotamine five times during the course of the next 48 hours. This maintained the postoperative pulse rate on a relatively level plateau, which gradually fell to below 100 on the fourth postoperative day. In this instance, the temperature was 104.4° F., while the pulse rate remained under 120 (Chart 4).

This case shows good control of the peak pulse rise during operation and a relatively stable pulse rate postoperatively, which stands in marked contrast to its preoperative instability.

Case 5.—Met. No. 731: W. P., white, male, age 38, was admitted to the Metropolitan Hospital, January 18, 1939. The basal metabolic rate was plus 38 on January 20; on February 1, plus 35, and on February 9, plus 2. During this period the patient received iodine therapy and the usual preoperative regimen.

Operation, February 14, under cyclopropane, was begun at 11:35 A.M., when the pulse rate was 80. At 1:30 P.M., the pulse had risen to 156; ½ mg. ergotamine was ad-

ministered, and at 1:45 P.M., the pulse rate had fallen to 110, at which time operation was completed.

The pulse rate at midnight was 90, when ¼ mg. ergotamine was administered. The next morning it had risen to 118; after ½ mg. ergotamine was given, the pulse rate fell during early afternoon to below 100. The subsequent convalescence was uneventful (Chart 5).

This case illustrates a well-controlled peak operative rise with a rather stable pulse reaction postoperatively under two doses of ergotamine.

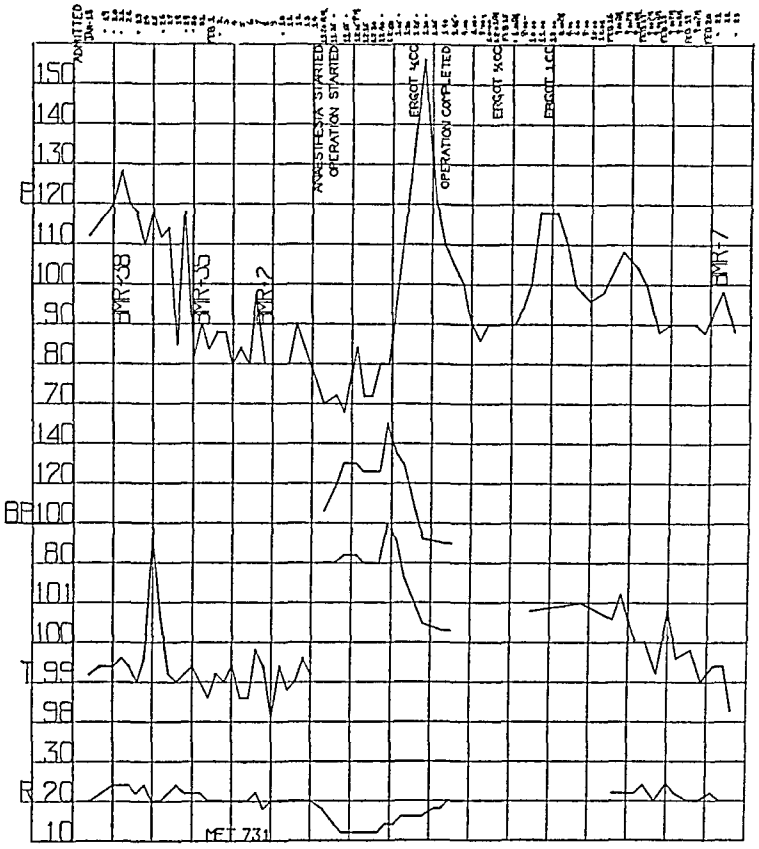


CHART 5.—Met. Hosp. No. 731: Shows the effect of ergotamine, ¼ mg., administered when pulse rate was 156; 20 minutes later, it had dropped to 100. Two postoperative doses of ergotamine maintained a fairly level postoperative plateau.

Discussion.—In 1913, Forcheimer[14] suggested the use of quinine and ergot in thyrotoxicosis in the preparation of patients for operation. Merke[15] recommended the use of ergotamine for the postoperative tachycardia following thyroidectomy, and reported several cases with beneficial results. This is the only reference to the use of ergot alkaloids in the surgical care of thyrotoxicosis noted in the literature and, as already mentioned, is concerned only with the postoperative period.

The medical treatment of thyrotoxicosis by means of ergotamine has had considerable application, but it would seem with rather indifferent results.

The first extensive clinical use of ergot alkaloids in the medical treatment of thyrotoxicosis was initiated by Adlersberg and Porges,[16] in 1924, and they reported,[17] in 1925, a series of cases with beneficial results following the use of the recently isolated ergot alkaloid, ergotamine. They reported another series of cases[18] in 1930, in which they showed a definite improvement in over one-half those treated. In 1931, Youmans and Trimble[19] reported some very interesting results. They found that the effect of ergotamine on the pulse rate was much more pronounced than the effect on the blood pressure. They, and others, report a slowing of the pulse in thyrotoxicosis which was more pronounced than in normal controls. The explanation for the lack of a more extensive application of this experience is probably, in part at least, dependent on the relative ease with which a tolerance develops. However, the potentiating action of thryroxin on adrenalin has not received from the surgeon or anesthetist the attention its essential and fundamental importance would seem to warrant. Some facts regarding this potentiating action seem worthy of mention.

Clark[20] gives some interesting statistics in this connection and makes the statement that adrenalin in a dilution of 1 in 10^{8}* gives certain characteristic and recognizable effects, but a similar result can be produced in a dilution of 1 in 10^{16}* if a solution of thyroxin 1 in 10^{16} is used as well. This being true, the potentiating effect of thyroxin on adrenalin must be enormous. These dilutions, however, are not so surprising as it may seem at first sight, when it is recalled that 1 cc. of a solution in a dilution of 1 in 10^{16} will, in the case of adrenalin, contain 300,000 molecules, and in the case of thyroxin 100,000 molecules. When these are distributed over the cells to be affected, it is obvious that an extremely small percentage of the cell surface could receive even a monomolecular layer of the drug, and this area where the drug is adsorbed may be spoken of as the pattern cell receptor. These figures may help to make comprehensible the efficacy of doses as small as those employed.

There is other evidence to suggest that such drugs as adrenalin, thyroxin, and ergotamine produce their effects by occupying cell receptors of a particular pattern with a monomolecular film. Andrus,[21] in 1932, and also Yater,[22] showed that hearts of thyroxinized animals continue to beat much longer *in vitro* than normal ones, and this effect persists for hours; this, of course, suggests an effect directly upon the heart muscle, whereas, when a heart is treated with atropine and adrenalin, the tachycardia subsides very quickly after being set up *in vitro*. However, reference should be made at this point to the fact that some observers do not accept the slowing of the pulse rate in mammals by ergotamine. For example, Dale[23] has shown that the efficiency of the cardiac accelerator antagonism by ergotamine is not too well established in mammals although the extreme results reported by Otto[24] have not met with substantiation. In any event, his results are subject to a different interpretation because the effect may not be a nerve mechanism at all, and Andrus

* The superior number of 10^{8} indicates one hundred million, and 10^{16} represents ten thousand million.

and Martin,[25] in dogs and cats, have obtained quite opposite findings. These authors have shown that when both vagal nerves were sectioned in the neck, and atropine given, the subsequent use of ergotamine still slowed sinus rhythm, and in their experience, subsequent injection of adrenalin failed to produce cardiac acceleration. They conclude that ergotamine produces effects without any relation to the vagus. Andrus and Martin[26] also showed that auriculoventricular conduction is depressed by ergotamine, with delay of transmission of excitatory processes in the auricle as shown by prolongation of the P—R interval in the electrocardiograph. Baur[27] has shown that ergotamine antagonizes the effect of adrenalin on the amniotic membranes of a goose's egg, which is totally lacking in nerve elements and, therefore, must represent a drug to muscle cell receptor mechanism of some kind. Rothlin[28] has shown that the heart of ergotaminized animals is more sensitive to vagal stimuli than is that of the controls.

In 1930, Matthes[29] showed that ergotamine has a specific inhibiting action on cholinesterase, but this is not nearly as sensitive, or as intimate, as that of eserine, nor will it work in equally extreme dilutions. This strongly suggests that ergotamine, by its action on cholinesterase, delays the destruction of acetylcholine and, hence, markedly potentiates vagal effects. Rake and McEachern[30] have shown that signs of hyperthyroidism in animals appeared only 36 to 48 hours after medication was begun. This is important, because any excess thyroxin appearing during the operative procedure could not explain the concomitant rise in pulse rate. Moreover, Collip[31] states that it is impossible to show an elevation of the basal rate after thyroxin therapy before ten to 12 hours. Rake and McEachern[32] also show that thyrotoxicosis in animals produces a decreased myocardial glycogen, but the heart showed no specific anatomic lesion, even after long continued use of thyroxin. Weller *et al.*[33] have rather definitely shown that there is no particular or specifically recognizable, morphologic myocardial lesion in thyrotoxicosis in humans.

The various mechanisms in operation to cause tachycardia might be grouped under three headings: (1) Increased adrenalin outpouring as a result of central and peripheral stimulation. (2) Thyroxin potentiation of adrenalin pattern cell receptor relationship in the specific tissue or conducting mechanism of the heart. (3) The action of thyroxin itself on the heart. The action of ergotoxine and ergotamine should be useful in minimizing the action of the first two with little, if any, effect on the third. In addition the vagal potentiation of ergotamine plays a definite rôle in the control of the tachycardia. This follows from the ergotamine-cholinesterase relationship resulting in enzyme inhibition and consequent prolongation of acetylcholine action.

Other Effects of Ergotoxine and Ergotamine.—Youmans and Trimble[34] report no untoward effects in patients treated over quite long periods with ergotamine. According to Barger, the harmful effects of therapeutic doses of ergotamine in a small percentage of subjects consist of slight giddiness, feeling of frontal pressure in the head, weariness, sometimes pain and soreness in the muscles, less frequently nausea and very rarely vomiting.

This brief discussion of the literature suggests that the tachycardia of thyrotoxicosis is not a compensating reaction but appears to be rather a fortuitous and undesirable event. Clinical experience would seem to adequately substantiate this, as most observers concur that its presence, particularly if long continued, adds greatly to the gravity of the condition. In any event, regardless of the mechanism responsible for the beneficial results obtained with this therapy, the present investigation brings substantial clinical evidence that this tachycardia can be advantageously influenced during the surgical care of thyrotoxicosis by the ergot alkaloids, ergotoxine and ergotamine.

CONCLUSIONS

(1) The ergot alkaloids, ergotoxine and ergotamine, are definitely useful adjuncts to the surgical management of thyrotoxicosis.

(2) The pulse rate in these cases seems better controlled than a comparable series without ergotoxine-ergotamine therapy.

(3) Ergotoxine and ergotamine have no recognizable effect on the tachycardia of anoxia.

(4) A supplemental oxygen supply, especially postoperatively, is of the greatest value in the surgery of thyrotoxicosis.

We wish to acknowledge our appreciation for the help received from Professor L. J. Boyd and Dr. David Scherf in the preparation of this communication, and to Miss Ethel Muller, Dr. W. T. Clark, and Mr. Alfonse LeMay for their services in the preparation of the charts.

REFERENCES

[1] Elliott, T. R.: On the Action of Adrenalin, Jour. Physiol., 31, 20, 1904.
[2] Loewi, O.: Über humorale Übertragbarkeit der Herznervenwirkung. Arch. f. d. ges. Physiol., 189, 239, 1921.
[3] Loewi, O.: Über humorale Übertragbarkeit der Herznervenwirkung II. Arch. f. d. ges. Physiol., 193, 201, 1921.
[4] Dale, H. H.: Chemical Transmission of Effects of Nervous Impulses. Brit. Med. Jour., 1, 835, 1934.
[5] Dale, H. H.: Croonian Lectures on Some Chemical Factors in the Control of Circulation. Lancet, 1, 1179; 1233; 1285, 1929.
[6] Brown, G. L., Dale, H. H., and Feldberg. W.: Reactions of the Normal Mammalian Muscle to Acetylcholine and Eserine. Jour. Physiol., 87, 394, 1936.
[7] Dale, H. H.: Progress in Autopharmacology (Charles E. Dohme Memorial Lectures). Bull. Johns Hopkins Hosp., 53, 297; 312; 329, 1933.
[8] Dale, H. H.: Physiological Actions of Ergot. Jour. Physiol., 84, 163, 1906.
[9] Barger, G.: The Alkaloids of Ergot. In: Heffter, A.: Handbuch d. exper. Pharmakol., Berlin, Springer, 6, 85, 1938.
[10] Barger, G., and Carr, J. H.: Quoted by Barger[9]: The Alkaloids of Ergot. P. 85.
[11] Stoll, A.: Quoted by Barger[9]: The Alkaloids of Ergot. P. 85.
[12] Clark, A. J.: Applied Pharmacology. Phila., Blakiston, 6th ed., 501, 1938.
[13] Navratil, E.: Über humorale Übertragbarkeit der Herznervenwirkung; Ergotamin und Accellerans. Arch. f. d. ges. Physiol., 217, 610, 1927.
[14] Forcheimer, F.: Quoted by M. W. Lev and W. W. Hamburger: Studies in Thyroid Heart Disease. Am. Heart Jour., 8, 134, 1932.
[15] Merke, F.: Über Cynergen bei Kropfoperationen. Zentralbl. f. Chir., 52, 924, 1925.

[16] Adlersberg, D., and Porges, O.: Favorable Influence of Ergotamine in Basedow's Disease. Wein. klin. Wchnschr., 37, 327, 1924.
[17] Adlersberg, D., and Porges, O.: Treatment of Graves' Disease with Ergotamin. Klin. Wchnschr., 4, 1489, 1925.
[18] Adlersberg, D., and Porges, O.: Über das Schicksal der mit Ergotamin behandelten Basedowkranken. Med. Klin., 26, 1442, 1930.
[19] Youmans, J. B., and Trimble, W. H.: Experimental and Clinical Studies of Ergotamine. Arch. Int. Med., 47, 612, 1931.
[20] Clark, A. J: General Pharmacology. In: Heffter, A.: Handbuch d. exper. Pharmakol., Berlin, Springer, 4, 22, 1937.
[21] Andrus, E. C.: The Heart in Hyperthyroidism; Clinical and Experimental Study. Am. Heart Jour., 8, 66, 1932.
[22] Yater, W. M.: The Mechanism of Adjustment of the Circulation in Hyperthyroidism (Thyrotoxicosis). Am. Heart Jour., 8, 1, 1932.
[23] Dale, H. H.: Quoted by Barger[9]: The Alkaloids of Ergot. P. 120.
[24] Otto, H. L.: Upon Action of Ergotoxin in Mammalian Heart. Jour. Pharmacol. and Exper. Therap., 33, 285, 1928.
[25] Andrus, E. C., and Martin, L. E.: Action of Sympathetic upon Excitatory Processes in the Mammalian Heart. Jour. Exper. Med., 45, 1017, 1927.
[26] Andrus, E. C., and Martin, L. E.: Action of Sympathetic on Excitatory Processes of the Mammalian Heart. Jour. Exper. Med., 45, 1024, 1927.
[27] Baur, M.: Quoted by Barger[9]: The Alkaloids of Ergot. P. 99.
[28] Rothlin, E.: Pharmacologic and Therapeutic Action of Ergot on Sympathetic Nerves. Klin. Wchnschr., 4, 1437, 1925.
[29] Matthes, K.: Action of Blood on Acetylcholine. Jour. Physiol., 70, 338, 1930.
[30] Rake, G., and McEachern, D.: A Study of the Heart in Hyperthyroidism. Am. Heart Jour., 8, 19, 1932.
[31] O'Donovan, D. K., and Collip, J. B.: The Production of an Increase in Metabolic Rates of Thyroidectomized Rabbits by Certain Pituitary Extracts. West. Jour. Surg., 45, 564, 1934.
[32] Rake, G., and McEachern, D.: A Study of the Heart in Hyperthyroidism. Am. Heart Jour., 8, 19, 1932.
[33] Weller, C., *et al.*: Cardiac Histopathology in Thyroid Disease. Am. Heart Jour., 8, 8, 1932.
[34] Youmans, J. B., and Trimble, W. H.: Experimental and Clinical Studies of Ergotamine. Arch. Int. Med., 47, 631, 1931.
[35] Barger, G.: The Alkaloids of Ergot. P. 107.

COEXISTING CARCINOMATA OF THYROID AND ABERRANT THYROID WITH REGIONAL METASTASES*

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Case Report.—L. C., white, female, age 23, unmarried, was admitted to the Medical Service of Beth Israel Hospital, July 7, 1938, suffering from bronchopneumonia of the right lower lobe. After this had subsided, the patient continued to have an irregular temperature ranging at times as high as 103° F. Diagnoses of infectious mononucleosis, typhoid, and typhus fever were entertained because of the associated symptomatology but were excluded by appropriate clinical and laboratory studies. Attention then was directed to an irregular, diffuse, chronic swelling in the right cervical region. This mass, which was first noted 12 years previously, when the patient was 11 years of age, had been growing slowly in size. Two years after onset hoarseness, irritative cough, choking sensations and dysphagia began. All symptoms had continued without interruption up to the present. A diagnosis of tuberculous lymphadenitis was made in 1935, and appeared to be supported by a roentgenogram of the chest, which at that time was stated to have revealed extensive thickening about the right hilar area and nodular infiltrations in both pulmonary fields. There had been no evidence of active pulmonary tuberculosis however, and the patient's general condition had always been satisfactory. Two months prior to admission an abscess, which had developed in the midst of the cervical swelling following the local injection of some solution by her family physician, was incised and drained. Because of the long-standing antecedent history of a mass, a biopsy was taken from the abscess cavity at the time, but was reported to reveal only "inflamed necrotic tissue." The wound healed without incident. The remainder of the past history was irrelevant.

Physical Examination.—On admission to the hospital, local examination revealed a chain of firm, painless, discrete and coalescing, globular masses extending along the right side of the neck, from the tip of the mastoid process to the clavicle. These masses, which paralleled the sternomastoid muscle, varied in diameter from one to three centimeters. The chain, in its lower third, overlapped the right lobe of the thyroid gland. The individual nodules were freely movable and were especially prominent immediately below the angle of the jaw. At that point also, they extended deeply toward the floor of the mouth. The overlying skin was not adherent except in the upper cervical region at the site at which the preexisting abscess had been drained. There was some asymmetry of the right side of the face, apparently the result of an old injury to the facial nerve. This followed the first of two operations for posttraumatic ankylosis of the right temporomandibular joint at the age of seven and 14, respectively. Healed transverse scars related to these operations were present in the submandibular and preauricular areas. Aside from moderate enlargement of the right lobe of the thyroid and displacement of the upper portion of the trachea to the left, there were no other significant local findings.

The febrile course subsided after four weeks without a definite diagnosis having been made, and in order to exclude the diagnosis of a localized form of Hodgkin's disease, one of the cervical nodules was removed for pathologic examination. The report, by Dr. Alfred Plaut, was as follows:

Pathologic Examination.—Gross: The specimen consists of a soft, cyanotic, encapsulated mass, measuring 3.3x3.1x2.2 cm. On cut-surface many glassy, grayish protru-

* Presented before the New York Surgical Society, November 22, 1939. Submitted for publication February 21, 1940.

sions with an average diameter of one millimeter and a number of larger indistinctly outlined yellow areas are seen.

Microscopically, the characteristic picture of papilloma of the thyroid was to be seen. The epithelium is mostly cuboidal. It is flattened in areas in which the stroma of the papillae is swollen. This stroma shows a variety of edematous and so-called hyaline changes. Varying degrees of metachromasia are seen in the stroma. Occasional small areas of calcification are noted. The stroma in some areas is inflamed; while in others, foreign body giant cells surround the crystal spaces. Small glandular areas resemble thyroid tissue. The adjoining lymph node tissue shows nothing unusual. *Pathologic Diagnosis:* Papilloma of thyroid (watch for recurrence).

In view of the fact that this nodule had been situated at a point quite far lateral to, and well above, the thyroid gland it seemed logical to assume that it did not constitute a portion of the gland proper but represented a tumor situated within aberrant thyroid tissue.



FIG. 1.—Photomicrograph of a regional lymph node, identified by presence of normal lymph follicles (indicated by arrows). Note invasion by papillary carcinoma (metastatic). (Low power)

On September 23, 1938, the patient was transferred to the Surgical Service and operated upon, under the diagnosis of benign papillary tumor of aberrant thyroid tissue. Avertin, gas-oxygen-ether anesthesia were employed. Through a typical Kocher incision, the ribbon muscles were separated in the midline and retracted laterally. On exploration, the left lobe of the thyroid gland was normal, the right lobe was enlarged about 50 per cent. The major portion of the latter was occupied by a rounded, firm, discrete, grayish-yellow tumor which measured about three centimeters in diameter. Attached to it, and extending downward behind the clavicle, was a chain of similarly rounded nodules ranging in diameter from one-half to three centimeters. Many of these nodules were in close relation to the lateral wall of the trachea and esophagus. A number of small, normal lymph nodes were noted among the tumor masses. Firmly wedged in the superior thoracic aperture, displacing the trachea far to the left side, and resting on the dome of the pleura, was a large nodule measuring about four centimeters in diameter. Extending upward from the right thyroid lobe, beneath the sternomastoid muscle and surrounding the carotid sheath, was a similar chain of tumor masses and lymph nodes.

In order to expose the lesion to its upper limit, the existing incision was curved upward and carried along the anterior border of the sternomastoid muscle almost to the mastoid process. The tumor masses, which ended at the lower border of the parotid gland, were found firmly attached to the carotid sheath and at a number of points appeared to infiltrate the overlying muscle. Beneath the ramus of the mandible, the masses extended mesially to the floor of the mouth and the hyoid bone. In the upper half of the operative field, there was considerable scarring as the result of three previous operative procedures (submandibular arthroplasty, incision of abscess, and biopsy).

The right lobe of the thyroid first was widely resected. This was followed by the excision of all visible tumor masses and lymph nodes, together with a considerable quantity of surrounding fat, upward to the lower border of the parotid gland and downward to the dome of the pleura. Neither the carotid artery nor jugular vein were sacrificed as these structures did not appear to be infiltrated and could be dissected free without undue difficulty. At the conclusion of operation, the right side of the trachea and esophagus and the carotid sheath were quite bare. A small gauze wick was placed down to the retroclavicular dead space and brought out through a stab wound behind the lower portion of the sternomastoid muscle. A second gauze wick, placed alongside the wall of the pharynx was brought out through the same stab wound. The ribbon muscles then were approximated in the midline, and the subcutaneous tissues united with interrupted sutures. The skin was closed with clips.

Sections taken from various parts of the specimen, including the right lobe of the thyroid, regional lymph nodes, and the lateral cervical nodules, were reported by Doctor Plaut as follows:

Pathologic Examination.—Microscopic: "Most of the sections reveal the picture of papillary tumor as described in the previous biopsy specimens. Some of the papillary masses are situated in almost entirely destroyed lymph nodes. There is one piece of nontumorous lymph node. Occasionally, small areas of nonpapillary or only slightly papillary adenocarcinoma are seen." *Pathologic Diagnosis:* "Papillary malignant tumor of thyroid and aberrant thyroid, metastasizing in lymph nodes."

The postoperative course was entirely uneventful, the wound healing by primary union. A prophylactic course of radiation, advised by the Department of Radiotherapy, was commenced on the tenth postoperative day and continued in the Out-Patient Department following the patient's discharge from the hospital. Follow-up examination at the present time, 14 months after operation, reveals the operative wound to be well healed. There is no evidence of local recurrence or distant metastases. Roentgenologic examination of the chest is negative, and the trachea, which formerly was displaced toward the left side of the neck, is now in the midline. The patient has gained 14 pounds in weight, is in excellent general physical condition, and is entirely free of symptoms except for the persistence of some hoarseness. The latter is due to paralysis of the right vocal cord resulting from removal of a portion of the recurrent laryngeal nerve intimately involved in a mass of nodules alongside of the trachea and esophagus.

DISCUSSION.—In a recent review of the thyroid material of the Cleveland Clinic, George W. Crile, Jr., stated that of 13 cases of papillary tumor of lateral aberrant thyroid tissue, five were associated with similar tumors situated within the thyroid gland proper. Cattell, also, has emphasized that in the presence of papillary lateral aberrant thyroid tumors, the thyroid gland proper is apt to contain one or more such lesions. The case which I have presented falls precisely into this group. In three of Crile's cases the thyroid tumor was considered malignant but in each instance the patient's course, following operation, has thus far been entirely satisfactory. Accordingly, Crile emphasizes that it is extremely difficult and at times impossible to distinguish between regional lymph nodes, invaded by metastatic papillary car-

cinoma arising in the thyroid gland proper, and multiple benign papillary tumors of aberrant thyroid tissue occurring concomitantly with benign papillary tumors of the thyroid gland erroneously considered malignant.

In the present case, the diagnosis of papillary carcinoma has been made independently by four pathologists. The evidence of malignancy of the tumor in the right lobe of the thyroid is not only its cellular structure but also invasion and infiltration beyond the limits of the capsule and into the connective tissue between the lobules. Another criterion is the presence of tumor tissue within structures which can be recognized readily as regional lymph nodes, the identity of the later being established by the presence of intact lymph follicles. The final evidence of malignancy is the presence of invasion of the capsule of certain large circumscribed tumor masses which represent either primary tumors of aberrant thyroid tissue or large lymph nodes whose structure has been grossly altered by extensive invasion of metastatic carcinoma arising primarily in the right lobe of the thyroid. The presence of a certain amount of lymphoid tissue within these nodules does not identify them as lymph nodes, since it is known that lymphoid tissue may be present normally in all lateral cervical embryologic anomalies such as cysts, sinuses, and aberrant thyroid tissue. There are, however, two features of the case which tend to establish the identity of the nodules in question, as of lateral aberrant thyroid origin. These are: First, the fact that the masses had been present for 12 years prior to operation (since the patient was 11 years of age); and second, that the wide distribution of the nodules from the mastoid process to the dome of the pleura would be most unusual for lymph nodes. A consideration of various clinical and pathologic features seems, therefore, to warrant the assumption that lateral aberrant thyroid tissue was present for many years; that papillary carcinoma developed in the right lobe of the thyroid gland and concomitantly in the aberrant thyroid tissue; and that the regional lymph nodes became involved by metastatic carcinoma from the thyroid gland tumor, or from the lateral aberrant thyroid tumors, or from both.

All authors appear to agree that papillary carcinoma of the thyroid and aberrant thyroid tissue is a highly differentiated, slowly growing lesion which exhibits a remarkably benign clinical course. Pemberton states that such a carcinoma may be present for a considerable period of time before invading the neighboring tissues and that, when nonencapsulated, it exhibits a predilection to spread to the regional cervical lymph nodes. Although the prognosis obviously is worse if there is regional lymph node involvement, it must be remembered that carcinomatous lateral cervical masses may represent lateral aberrant thyroid tissue involved by primary carcinoma and not regional lymph nodes involved by metastatic carcinoma. Even if the existence of the latter is established, as was done in the present case, radical removal is still indicated. Because of the high degree of differentiation of the tumor and its radioresistance, all observers now agree that pre- or postoperative radiation is of little or no value. If postoperative recurrence is noted, further operation rather than radiotherapy is indicated for the reason just stated.

PAPILLARY ADENOMA OF ABERRANT THYROID*

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TUMORS of aberrant thyroid, which appear as papillary adenoma or adenocarcinoma, are relatively uncommon. George Crile, Jr.,[1] in a recent paper reviewing 17 cases from the Crile Clinic, stated that, including his own, 136 cases had been reported in the literature to date.

Case Report.—E. L., male, age 24, was admitted to St. Luke's Hospital in October, 1939, complaining of swelling on both sides of the neck, recently increasing on the left. This had first been noted about ten months previously. Six months ago, at another hospital, a biopsy from the right side of the neck was obtained and a diagnosis of papillary carcinoma, probably orginating from the thyroid, was made. He was given two courses of radiotherapy to the neck without relief. Operation was advised but not accepted at that time.

On examination, although thin and delicate in appearance, he was not acutely ill. There were firm masses suggesting enlargements of the nodes on both sides of the neck along the sternomastoid muscles. On the right side they extended to the level of the angle of the jaw above. On the left the base was lower and broadened out laterally just above the clavicle. The thyroid did not seem enlarged but small hard nodules were palpable in the isthmus. Roentgenologic examination revealed a mass in the upper mediastinum pushing the trachea somewhat to the left. The basal metabolism was ± 0.

The right side of the neck was operated upon, October 18, 1939, through an incision along the sternomastoid muscle. Two firm masses lying in a vascular, areolar tissue between the muscle and the internal jugular vein were removed. The thyroid gland was not exposed satisfactorily through this incision, nor could a mediastinal mass be felt.

During the operation, which was performed under colonic ether, the patient's breathing was continually obstructed, and after he was returned to the ward he became so cyanotic that it was necessary to introduce an intratracheal tube. In this connection, it is interesting to note that on the day after his biopsy, six months previously, the patient was said to have become suddenly extremely cyanotic, and breathing to have stopped, requiring artificial respiration and stimulants.

A second operation was performed November 3, 1939, under intratracheal anesthesia. At this time the usual thyroid incision was made. The mediastinal mass, below and distinct from the right lobe of the thyroid gland, proved to be an aberrant thyroid extending from the right side of the trachea and posteriorly to it. It was removed with some difficulty. The isthmus of the thyroid and the anterior inferior portion of the right lobe were found to contain tumor, identical on frozen-section with that of the aberrant tumors, which extended downward on the front of the trachea. After its removal, the presumably normal left lobe and upper one-third of the right lobe of the thyroid remained.

A third operation was performed November 17, 1939. As the mass in the lower left neck extended so far laterally, it was thought better to approach it through a transverse rather than oblique incision. Consequently, two transverse incisions were made. Through the upper one, a mass was removed from underneath the sternomastoid muscle at about the level of the hyoid bone and through the lower two masses, one solid the other cystic in part, lying mainly under the clavicular origin of the muscle. Gas

* Presented before the New York Surgical Society, November 22, 1939. Submitted for publication February 21, 1940.

anesthesia, without an intratracheal tube, was employed for this operation, with no respiratory difficulties. *Pathologic Diagnosis:* Papillary adenoma of aberrant thyroid and thyroid.

Points of interest are involvement of both sides of the neck, which was found in five of Crile's 17 cases, simultaneous involvement of the thyroid, found in eight of Crile's cases, and the mediastinal location of one tumor causing pressure on the trachea and interference with breathing. Crile reported a mediastinal tumor in five of his series.

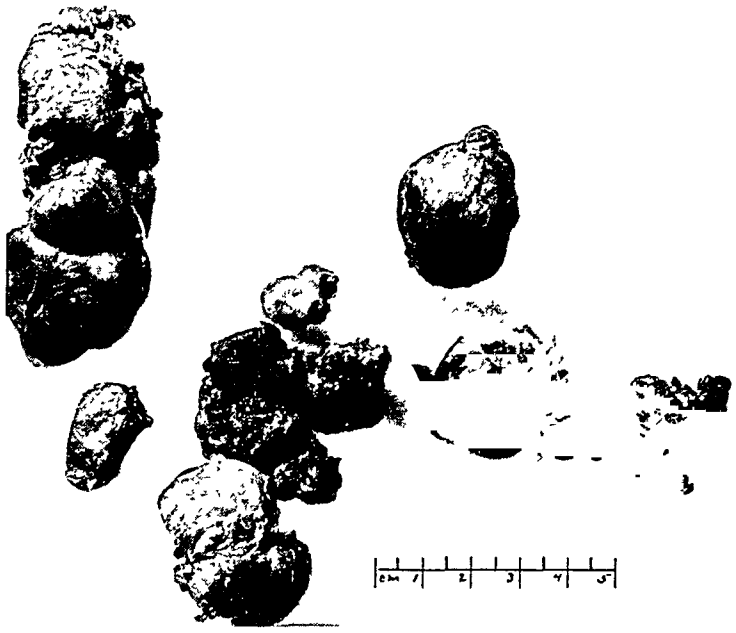


FIG. 1.—Tissue removed from Case E. L. Lower, center mediastinal mass. Just above it tumor removed from thyroid.

The question of greatest importance in these tumors is that of malignancy. About one-third of those reported are classified as carcinomata. The late results indicate, however, that the grade of malignancy, when present, is low.

REFERENCE

[1] Crile, George, Jr.: J.A.M.A., 113, 1094, September 16, 1939.

DISCUSSION.—DR. CHARLES GORDON HEYD (New York) called attention to the well-established fact that certain types of heart disease associated with hyperthyroidism exhibit rather miraculous cures after surgical intervention. The unfortunate part of heart disease in goiter is that most of these patients come to Cardiac Clinics for their disabilities, where they are treated for an indefinite time before being submitted to the beneficent effects of surgery. When told eventually that their cardiac condition is in a large measure due to their goiter condition, they express great surprise and state that they have not had a goiter for many years and that it has given no trouble. It is sometimes very difficult to convince them that the heart disease is largely due to a goiter that apparently gave no symptoms. Yet the effort must be made, because, as illustrated by Doctor Smith's case, there are few individuals, in the

field of cardiac pathology, who can be so improved by surgery as the patient with cardiac symptoms due to hyperthyroidism.

DR. ARTHUR P. STOUT (New York) described the experiment undertaken at the Presbyterian Hospital with tumors of the lateral aberrant thyroid. Before doing so, however, he quoted Doctor Crile as follows: "It has not been proved that either distant or local metastases occur from papillary tumors of lateral aberrant thyroid origin." Furthermore, "none of the 13 patients in this series has died as a result of lateral aberrant thyroid disease. . . ." and, speaking of papillary tumors of the thyroid gland, Chile has said: "In no instance has it been proved that either regional or distant metastasis took place."

At the Presbyterian and Babies Hospitals, there have been 22 cases of lateral aberrant thyroid disease designated as follows: Simple hypertrophy, one case. Adenoma, five cases. Benign papillary tumor, three cases. Carcinoma, thirteen cases. Of the carcinomata, ten were of the papillary type, three of the solid type. Of the 13, three were males, ten females. Seven of the 13 had tumors in the thyroid, also; two of them had bilateral involvement—just as Doctor Smith's case had. One four-year-old child had bilateral involvement, with a nodule in the thyroid, also. The other case had no nodule in the thyroid but tumors in both sides of the neck.

In regard to lymph node metastasis, in order to accept the occurrence of metastasis, inasmuch as the lateral thyroid nodules have lymphoid tissue in them, it is necessary to find the actual structure of the lymph node with its sinuses and its follicles. In order to determine whether or not those nodules which had been called metastases fulfilled the criteria, Doctor Stout recently reviewed the cases mentioned and found that six cases did have isolated papillary growths in unmistakable lymph nodes. Therefore, he felt that metastasis can occur in lateral, aberrant thyroid, malignant tumors. As to the results in these cases: Three of the 13 carcinoma patients have died—two with local recurrence and one with lung metastases. Hence, like other malignant tumors, carcinoma of the lateral aberrant thyroid may have a fatal outcome. Three of the patients are alive, at various periods, up to eight years, after the operation, with local palpable nodules. Whether or not these are cases of persistence of the tumor or newly developed lateral thyroid nodules, Doctor Stout could not specify. Seven are well, but only two of the seven have been well more than three years. There have been a number of these cases during the last two years.

In contradistinction to Crile's statement that metastasis from papillary tumors of the thyroid never occurs, Doctor Stout said that in going over the tumors of the thyroid at the hospitals mentioned, he found that four cases of papillary carcinoma also had metastases in lymph nodes. Therefore, in Doctor Stout's experience, although it is perhaps the least malignant of the thyroid tumors, papillary tumors are not without some threat to life.

DR. FRANK B. BERRY (New York) described a case that he had had with multiple aberrant foci in the neck, right lobe of the thyroid, and mediastinum 28 months ago. All were removed including complete removal of the right lobe and isthmus, with suspicious nodules in the right lobe reported as normal thyroid. The patient is well. She was 19 years old at the time of operation, and the condition was first noticed when she was 12 years old. She had been under the care of an internist in the interval period and these masses were thought to be tuberculous lymph nodes. Two or three months before she came to Doctor Berry they had begun to increase in size.

DR. HERBERT WILLY MEYER (New York) said that he, too, had operated upon a case of papillary adenocarcinoma occurring in an aberrant thyroid. The patient was a woman, age 55. The tumor was in the outer portion of the right side of the neck, about the size of a walnut, and was freely movable. There were no palpable lymph nodes. Careful nasopharyngeal examination was negative and roentgenologic examination of the chest was also negative. Two aspiration biopsies had been performed at another hospital, but the patient stated that no definite diagnosis could be made. She was operated upon, December 13, 1937, at the Lenox Hill Hospital. Pathologic examination revealed a typical papillary adenocarcinoma occurring in aberrant thyroid tissue. The mass was easily removed, being encapsulated. She made an uneventful recovery, and is entirely well two years since operation.

From the few cases previously reported before the New York Surgical Society, this condition could be considered quite rare. But in view of the large number of cases cited at this time from various clinics, one must change his point of view and consider it to be much more frequent.

The first case presented before the New York Surgical Society was on May 10, 1910, when Dr. Eugene Pool reported upon a patient operated upon by Dr. Frank Hartley. This was a papillary carcinoma in an aberrant thyroid with definite lymph node metastasis. In 1914, Dr. Walton Martin reported a similar case; then there was no further report until 1926, when Dr. Richard Lewisohn reported a case of bilateral, symmetrical aberrant thyroids. The last previous report was in 1930, when Dr. Seward Erdman reported an adenocarcinoma of aberrant thyroid tissue occurring within the parotid gland.

Doctor Meyer showed a lantern slide depicting a reconstruction model of a human embryo, made in 1906, by the Russian surgeon, Wenglowski. It showed how the thyroid tissue comes down from the foramen cecum in the thyroglossal tract to form the isthmus and the main body of the thyroid gland. The lateral lobes develop from the epithelial pocket in the floor of the fourth pharyngeal pouch. A more detailed description of this may be found in an article published by Doctor Meyer entitled "Congenital Cysts and Fistulae of the Neck," in the February, 1932, issue of the ANNALS OF SURGERY. It is, undoubtedly, from the lateral remnants of thyroid cells that these tumors of aberrant thyroid tissue develop. They are usually outside the internal jugular vein or may lie just in front of it.

It must not be forgotten that aberrant thyroid tissue can also be present in other parts of the body. Billings and Paul, quoted by Cattell, from the Lahey Clinic, in 1931, reported 34 authentic cases collected from the literature from 1857 to 1923. Cattell reported 13 additional instances. In the world literature, however, there are numerous reports of aberrant thyroid tumors; on the average about 12 cases a year for the past ten years. These were both benign and malignant. The greatest number occurred at the base of the tongue. The second most frequent location, as reported, is in teratoma of the ovary.

Doctor Meeker, of the New York Post-Graduate Hospital, has collected a group of cases from that hospital, in which aberrant thyroid tissue has been found at the outer ends of the clavicle, in the pineal gland within the brain, within the brain itself (several cases), in the testes and in the prevertebral area within the abdomen. In the literature, one finds that aberrant thyroid tumors have also been found in the long bones, skull, pericardium, pleura, intratracheal, intralaryngeal, retropharyngeal, within the lungs and in the retina of the eye.

One and one-half years ago, Doctor Meyer operated at the Post-Graduate Hospital upon a case in which the pathologists finally agreed that the tumor

was probably a primary carcinoma of aberrant thyroid tissue occurring in the intercostal structures on the left side of the chest. A resection of the chest wall was performed. The patient did not have a local recurrence, but died one year after operation from what was believed to be a spinal metastasis with paralysis. Unfortunately, an autopsy could not be obtained.

One important point to remember is to try and determine the presence of a normal thyroid gland in its normal location if one suspects a tumor of aberrant thyroid tissue. Cases are reported in the literature in which myxedema developed after the removal of aberrant thyroid tissue, the tissue probably being the only thyroid tissue present.

SUBSTERNAL THYROID*

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Case Report.—*U. H. No. 567901: A. H., white, male, age 55, surgeon,* was admitted to the Presbyterian Hospital, December 11, 1938. His previous and family histories were irrelevant, except for the fact that one year previously, having had some precordial distress, an electrocardiogram was made which was found negative. A roentgenogram of the chest at that time revealed a large, intrathoracic goiter on the right side, with deviation of the trachea to the left. He was busy, and so relieved by the negative electrocardiogram report that he postponed action on the goiter, which had given no symptoms of any kind.

Five months before admission, gradually increasing hoarseness appeared, which, one month before admission, had assumed major proportions. At times he was completely aphonic; and at all times his voice was not much better than a hoarse whisper. Laryngeal examination by various examiners could be summarized as follows: The right cord and arytenoid were in the midline, and immobile. The left cord and arytenoid were usually noted in the cadaveric position, and exhibited but little motion.

Temperature, pulse, respiration, blood pressure, and physical examination in general were all negative, except for a firm mass, palpable just above the right clavicle, which obviously continued below that level.

Here was a patient, then, who presented a large intrathoracic goiter, with not only an ipsolateral paralysis but a marked contralateral weakness of the vocal cords.

The possibility of carcinoma was, of course, seriously considered; but the lung fields were innocent of any shadow suggesting metastasis.

Operation.—Under cyclopropane by the intratracheal route, the left lobe was found to be soft and apparently normal, as was the upper part of the right lobe. A large, nodular mass, about 13 cm. in length and about 8 cm. in diameter, arose from the lower part of the right lobe, and extended well down into the thorax. The depressor muscles were divided; the superior and inferior vessels were ligated on the right side; and the isthmus divided. Most of the right lobe was excised; and although the vascular supply to the intrathoracic mass had been controlled, it was impossible to deliver the tumor, because of the disparity in size between it and the superior aperture of the thorax. There seemed to be no evidence of infiltration into the surrounding tissues, strongly suggesting that the mass was not carcinomatous. Therefore, the dome of the tumor was removed, and a large amount of the central portion of the tumor was scooped out. Several curved clamps were then applied, one blade inside and one outside of the capsule; and it was then possible, by traction on the clamps, and with finger and sponge stick, to deliver the mass from the thorax. When the mass was delivered, it was a simple matter to remove it. Study of the field revealed the presence of parathyroids in place, and the right recurrent nerve was identified. The incision was closed without drainage.

The patient made an uneventful convalescence, and was discharged on the seventh postoperative day.

His present condition, *11 months following operation, is* very satisfactory. A roentgenogram shows the trachea in the midline; and examination of the vocal cords shows that they both function as if normal.

This case is shown as an unusual example of bilateral, recurrent nerve

* Presented before the New York Surgical Society, November 22, 1939. Submitted for publication February 21, 1940.

palsy due to intrathoracic goiter, with complete restitution of function following operation. I confess that I cannot explain the exact mechanics of either the ipsolateral or contralateral paralysis. The contralateral type exists often enough to make it essential to determine, in any given case with vocal cord weakness, whether it is the nerve on the same or on the opposite side that is involved. This case also demonstrates the value of scooping out the central portion of a mass that is too large to deliver from the thorax; and it is suggested that the application of several curved clamps to the capsule is a good method of applying traction in some of these difficult procedures.

DISCUSSION.—DR. RODERICK V. GRACE (New York) remarked that the complication that occurred in Doctor Parsons' patient is a very rare one. Unilateral root nerve paralysis has been reported as frequently as occurring in 15 per cent of total intrathoracic goiters. Bilateral paralysis, however, is so rare that Doctor Grace could find only one other case similar to that reported by Doctor Parsons, which had been reported by Dr. George M. Curtis, of the Billings Clinic, in 1931.

DR. CARL EGGERS (New York) cited a case of intrathoracic or mediastinal goiter.

Case Report.—Mrs. V., age 55, was admitted to Lenox Hill Hospital, February 26, 1939, with the diagnosis of mediastinal tumor, probably malignant. Her outstanding symptoms were dyspnea, cough, cyanosis and loss of 40 lbs. in weight. There was a history of an old heart affection of many years' duration.

Physical Examination.—The patient was a small, rather stout woman, weighing 118 lbs., with a short, thick neck. There was a spinal deformity which projected her head forward and made examination difficult. Cyanosis and the presence of greatly dilated veins over the anterior chest were the outstanding findings. The presence of a nodule in the thyroid, a pulse of 120, and the marked loss of weight called attention to the possibility of a goiter. A roentgenogram of the chest showed a tumor in the upper mediastinum. Basal metabolism, plus 53. She was a poor operative risk on account of her heart disease and the deformity of her neck. For this reason, she was placed under the care of a cardiologist and a course of roentgenotherapy was administered. There was absolutely no improvement. Operation seemed to offer the only hope of relief.

Operation.—Under local anesthesia, a subtotal thyroidectomy was performed, which was very difficult on account of the awkward position of the head. A large, nodular goiter was found. There was no extension into the thorax, and with the palpating finger no tumor mass could be felt in the mediastinum. We revised our opinion and thought we were dealing with two conditions. However, when no improvement resulted, when her pulse rate remained high, the basal metabolism continued unchanged, and the radiographic examination showed a persisting mediastinal shadow, it was decided that the condition was best explained on the basis of an aberrant thyroid. On account of the severity of the pressure symptoms its removal became imperative.

Second Operation.—Under local anesthesia, the entire manubrium was resected. Both pleurae were exposed but not injured. A large, nodular tumor occupied the entire upper mediastinum, firmly compressing the trachea. It had to be removed in pieces, which was accomplished without injury to other structures, and without bleeding. The patient stood the operation well and felt so relieved that a satisfactory result was expected. However, she developed a very acute, fulminating hyperthyroidism which resisted all measures to combat, and led to a fatal outcome after about 30 hours.

In summary, the patient was one in whom pressure symptoms, rather than toxic symptoms, predominated, but in whom acute hyperthyroidism caused

death. The gross as well as the miscroscopic pathology of the cervical and the mediastinal thyroid was identical, and showed degenerating colloid and hyperplastic goiter. There were no evidences of malignancy.

DR. A. HOLZMAN (New York) said that inasmuch as he was the patient who had possessed this unusual condition, he felt that a few personal remarks about symptomatology and outcome might be of interest. The first symptom was precordial pain that was not brought on by any effort but was almost continuous. Whether lying down, sitting up or standing, whether exerting himself or not, Doctor Holzman said the amount of pressure directly over the trachea was of a certain intensity. The last symptom to develop was intermittent hoarseness. At times his voice was normal; again, there was complete aphonia. This situation was very embarrassing because it prevented the carrying on of one's work. The type of anesthesia employed at operation was ideal; there was no pain during, immediately, or some time after the operation, and the end-result is excellent. Doctor Holzman said that his voice had fully returned to normal, even to such an extent that he is able to resume singing as a tenor in a choir.

AN OSTEOPLASTIC NEUROLYSIS OPERATION FOR THE CURE OF MERALGIA PARESTHETICA

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THE PURPOSE of this article is to present, for the cure of severe cases of meralgia paresthetica, an operation which is apparently new. In the past, resection of the lateral femoral cutaneous nerve has been the operation of choice. But even this radical measure has not always been successful (Bramwell[1]). The causes for failure were: (1) Formation of a neuroma at the proximal end of the divided nerve; (2) resection too far distal to the inguinal ligament; and (3) mistaken diagnosis, in that the lateral femoral cutaneous nerve was secondarily involved either because of an inflammatory process originating in an organ adjacent to its course, such as appendicitis, or because tumors pressed on the nerve. Again, it must be remembered that resection of the lateral femoral cutaneous nerve produces complete anesthesia over the lateral aspect of the thigh. The ideal treatment, therefore, would be one which not only relieves the patient of his pain but also restores to him normal sensation in the involved area.

Case Report.—J. W., white, male, age 46, was admitted to the Johns Hopkins Hospital, February 16, 1936, suffering from pain and numbness in the right thigh.

Previous History.—About five years before admission he noticed numbness in the skin of the outer part of his thigh immediately above the knee. Pain gradually appeared in the numb area, and the hair in this region became scant and short. Hyperextension of the thigh was constantly necessary in his work, and he found that this form of exertion was conducive to the production of the pain which was burning in character. The mere rubbing of his clothes on the affected part of his thigh also frequently produced the pain. Massage, hot compresses, salves and ointments were used without much benefit. Complete rest in bed was the most helpful measure. Because the pain was constantly increasing in severity, hampering him at his work, and causing much loss of sleep, he applied for relief.

Physical Examination.—Except for the sensory disturbance of the right thigh, the examination was essentially negative. The patient was five feet eight inches tall, of very muscular build, and weighed 175½ pounds. The lateral aspect of the right thigh was apparently normal in appearance except for the hair which was sparse, short, and brittle in the area marked T in Figure 1. This figure also shows the extent of other sensory disturbances, and covers, fairly well, the cutaneous distribution of the entire lateral femoral cutaneous nerve. Firm pressure on the nerve at the anterior superior spine of the ilium was not painful. The left thigh showed no sensory changes.

Laboratory Data.—Blood pressure 115/68; hemoglobin 100 per cent; white blood cells, 11,000; Wassermann reaction negative; van den Bergh negative; basal metabolic rate plus 7.

Operation.—February 18, 1936: Under avertin and gas-oxygen anesthesia, the right lateral femoral cutaneous nerve was exposed through a transverse incision which was

Submitted for publication June 6, 1939.

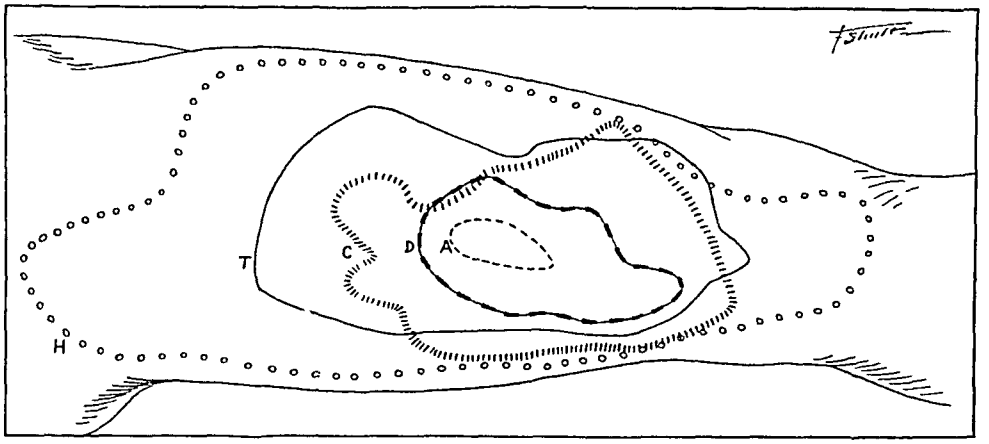


FIG 1.—February 17, 1936 Patient J W Lateral aspect of right thigh Sensory disturbance of skin before simple neurolysis of the lateral femoral cutaneous nerve on February 18 1936 Legend for this and all other sensory charts (A) Area of complete anesthesia to pin prick, (D) area in which the pin prick is experienced as a dull sensation, (C) area in which the sensation of cold is not recognized, (H) area in which the sensation of heat is not felt, (T) area in which the sensation of light touch (wisp of cotton) is not perceived

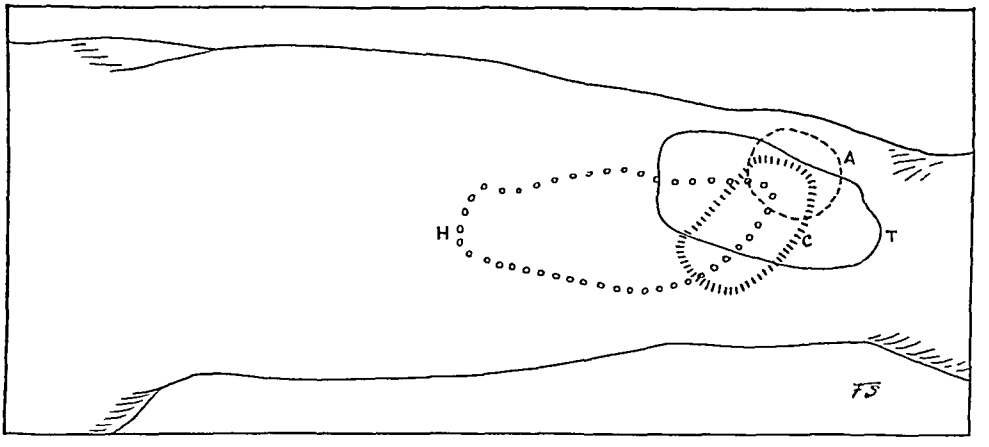


FIG 2.—February 19, 1936 Day after operation Note the extensive improvement There is much overlapping of the sensations

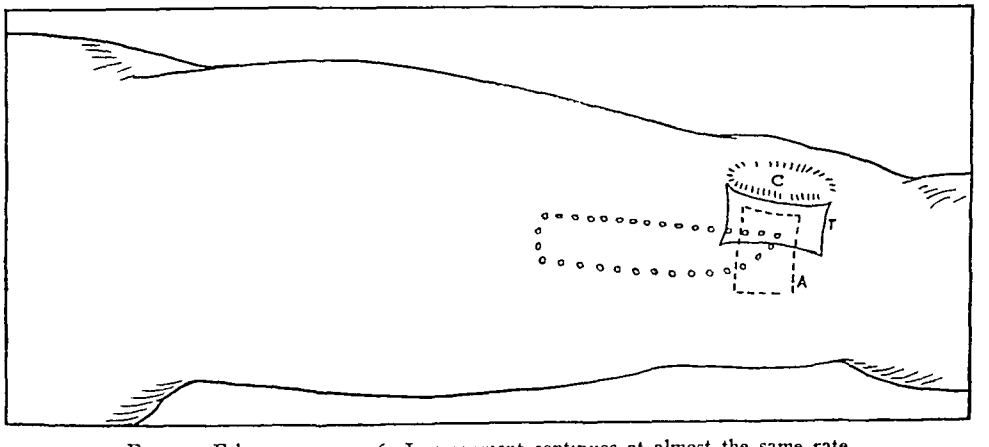


FIG 3.—February 20, 1936 Improvement continues at almost the same rate

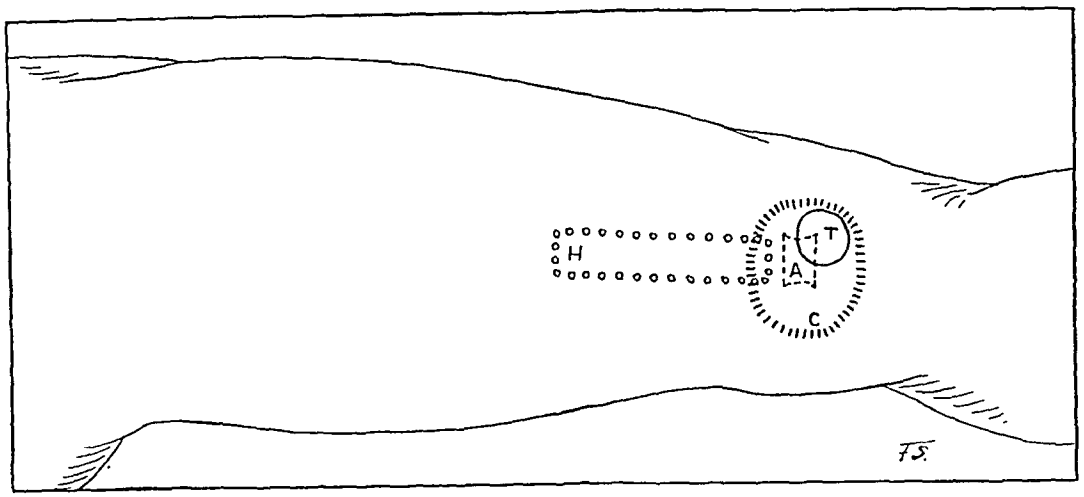


FIG. 4.—February 21, 1936: Improvement less. Overlap of sensations with a marked shift in the "cold" area.

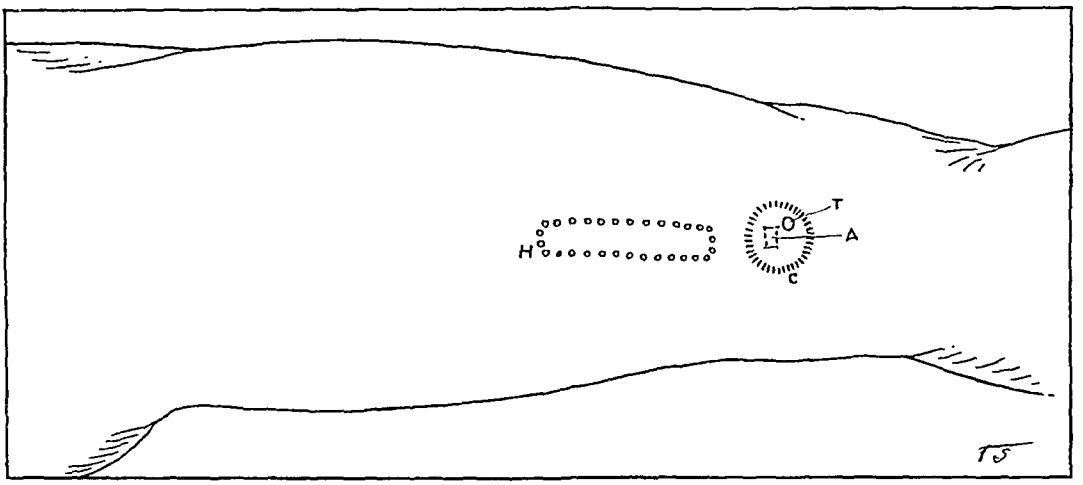


FIG. 5.—February 22, 1936: A curious separation of areas. Improvement continues but at a much slower pace.

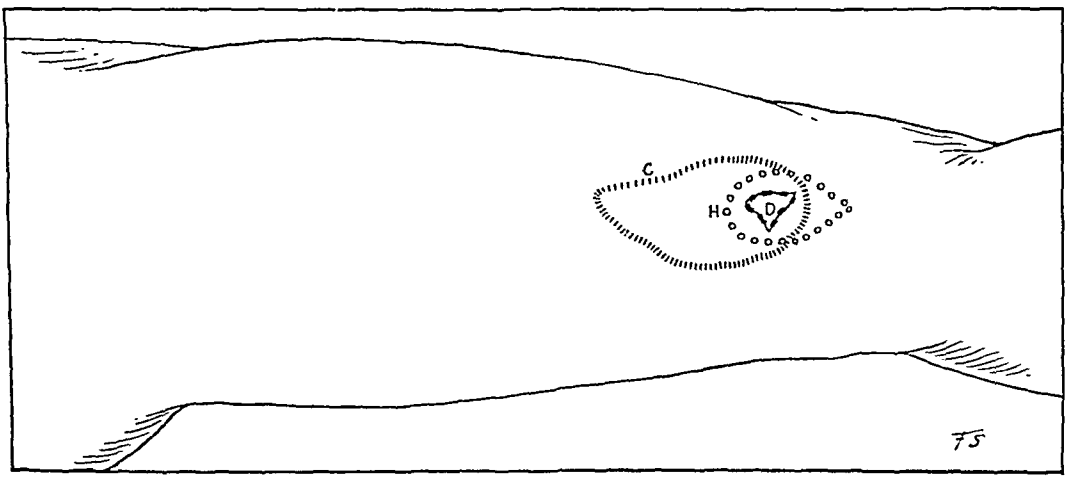


FIG. 6.—March 22, 1936. About one month after operation: There is no longer an area anesthetic to pin prick, but improvement seems to have been arrested. The "cold" area is much longer. There is no overlap.

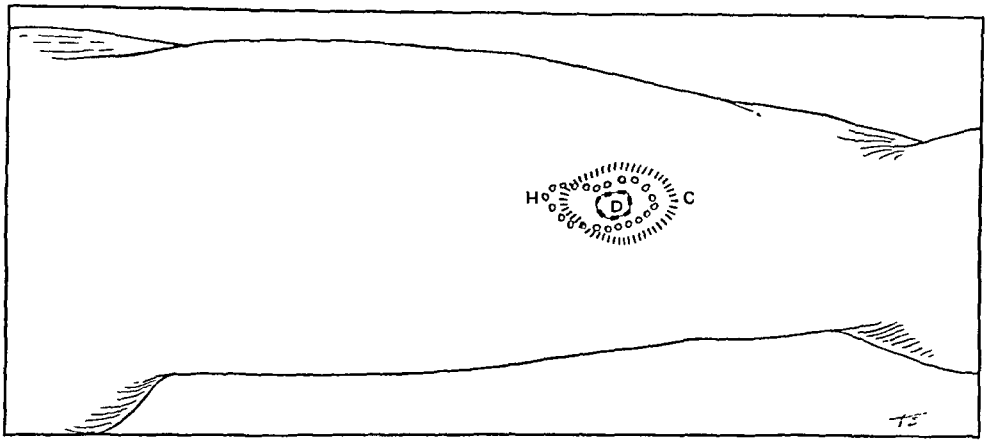


FIG. 7.—May 24, 1936: Still some improvement, but occasional pains were still present.

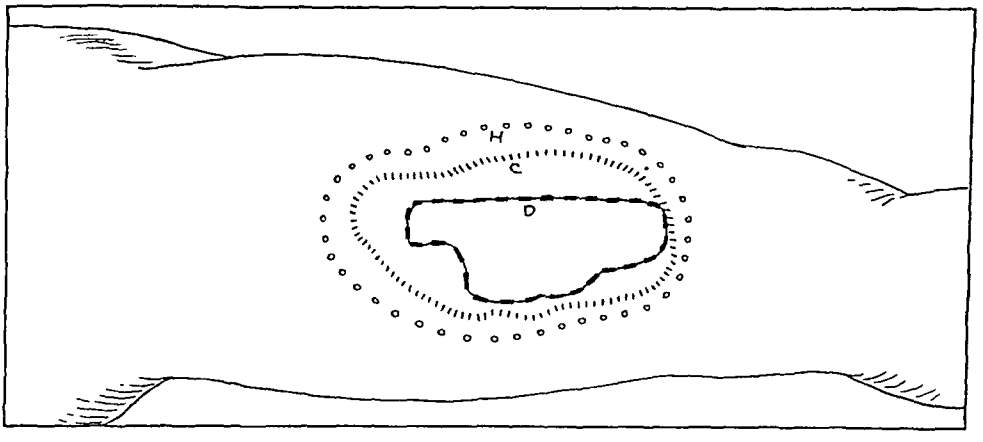


FIG. 8.—October 4, 1936: Sensory changes much worse. Shooting and burning pains more intense.

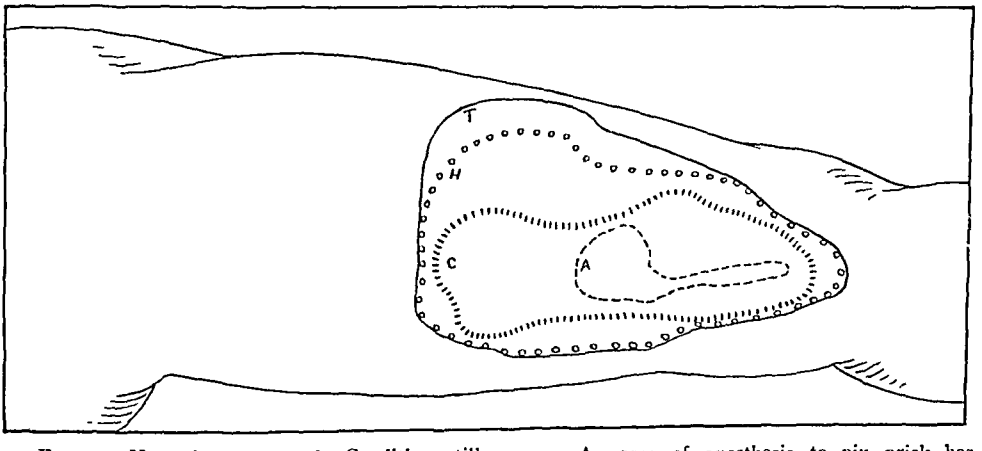


FIG. 9.—November 30, 1936: Condition still worse. An area of anesthesia to pin prick has appeared. There is no overlap of sensations. Pains were severe and almost prevented him from working. (Compare with Figure 1.)

made slightly below the anterior inferior spine of the ilium. The nerve was compressed for a distance of 0.5 cm. under the inguinal ligament. Above and below this constricted area the nerve was 2.7 Mm. wide and 1.2 Mm. thick, whereas at the compressed area it was 1.7 Mm. wide and 0.8 Mm. thick. All measurements were made with calipers. The nerve was thus compressed to 40 per cent of its normal size. In freeing the nerve, it was necessary to cut the lower fibers of the inguinal ligament, but, even then, only the tip of the index finger could be inserted between the nerve and the underlying bone. Since such a simple neurolysis had cured a previous case, a simple closure of the subcutaneous tissue and skin was undertaken.

The patient was not in condition to respond accurately to tests on the afternoon of the day of the operation, but those made during the four subsequent days showed daily improvement (Figs. 2, 3, 4, and 5).

Subsequent Course.—About one month later, March 22, 1936, after having worked for two weeks, stiffness and a mild burning pain began to return. Rainy weather made the condition worse. Sensory changes are shown in Figure 6.

About three months after operation, May 24, 1936, a sensory examination (Fig. 7) showed small improvement. He continued to work, but had occasional shooting pains.

During the following five months the burning pain gradually increased in frequency and intensity to such an extent that he again considered giving up his job. He was reexamined October 4, 1936, and it was found that his condition had become worse (Fig. 8).

This unfavorable course was considered parallel to that of the first patient[6] (H. H.), who gradually became worse after simple neurolysis until the seventy-second day, but subsequently improved and was completely cured eight and one-half months after operation, and has remained well now for over four years.

He returned to the hospital, November 30, 1936, complaining of much pain and disability. It was difficult to fall asleep. Sensory changes were less (Fig. 9) than on the first admission. The chief trouble was with the longest nerve fibers which went to the knee.

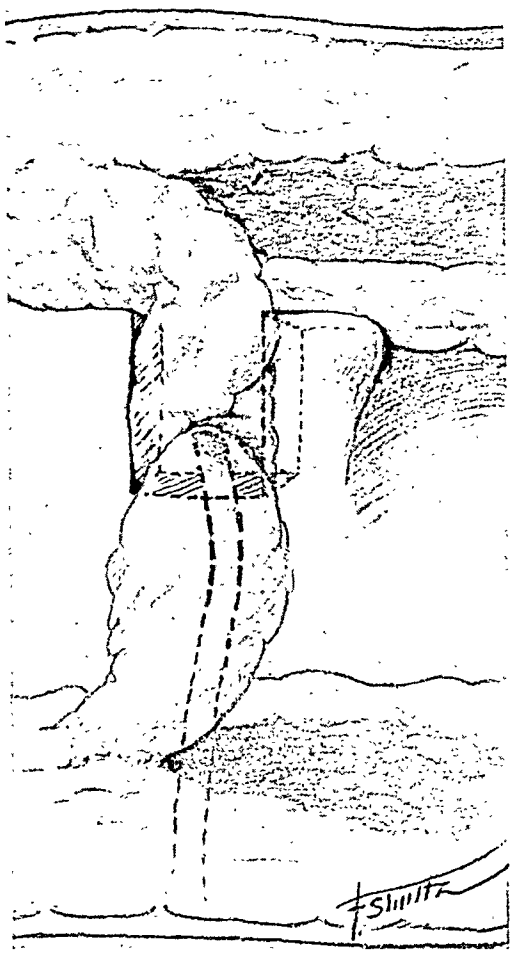


FIG. 10.—Drawing to show the main points in the osteoplastic neurolysis operation. A slot is cut in the crest of the ilium posterior to the anterior superior spine, and the lateral femoral cutaneous nerve (dotted outline), surrounded by fat pedicles, is placed into this new position. Pressure and tension can no longer exert force on the nerve.

It was decided to attempt another neurolysis operation because: (1) The immediate benefits of the first operation were striking; (2) there was still some improvement (compare Figs. 1 and 9); (3) the nerve had not received as much freeing as in the previous case; (4) his muscular build and type of work promoted fibrosis at the operative site; and (5) if neurolysis should fail again, then the nerve could always be resected.

The immediate problem was to devise an operation which would give more freedom to the nerve; put it under less tension; and surround it with fat in order that subsequent fibrosis and compression might be forestalled as much as possible.

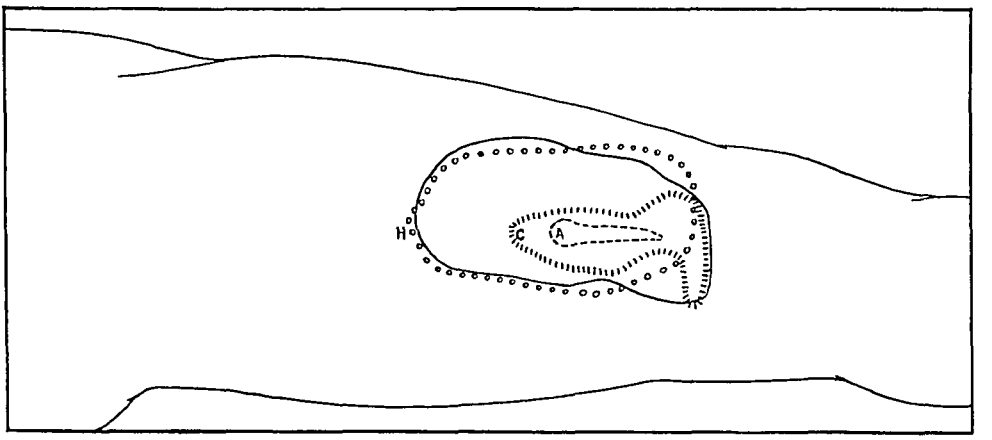


FIG. 11.—December 2, 1936. Day after osteoplastic neurolysis operation: Note again the marked sensory improvement.

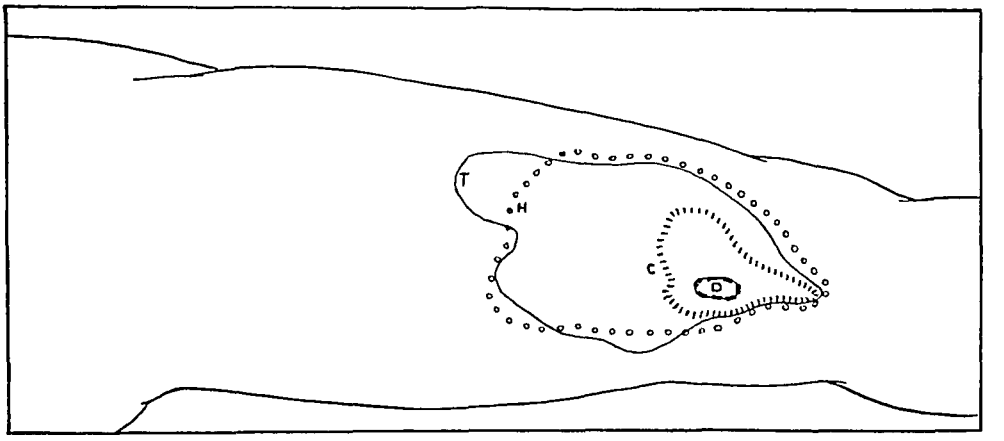


FIG. 12.—December 3, 1936: Condition temporarily worse. Note absence of anesthesia to pin prick.

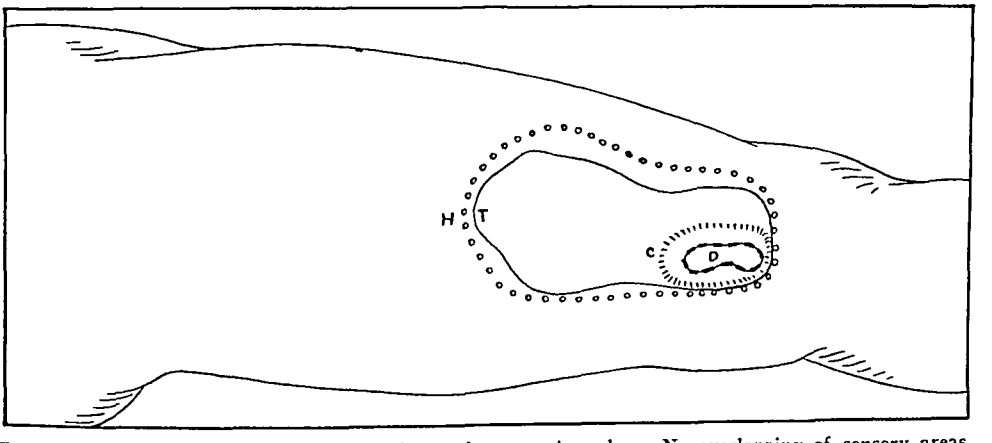


FIG. 13.—December 4, 1936: Not much change from previous day. No overlapping of sensory areas.

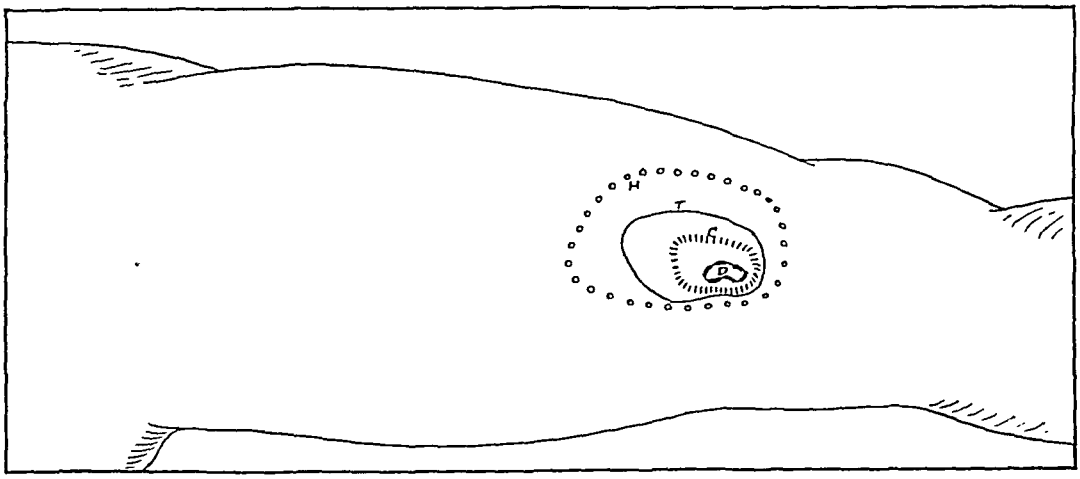


FIG. 14.—December 5, 1936: Very marked improvement, particularly to sensations of light touch and cold. (Compare with Figure 5 for the corresponding period after operation.)

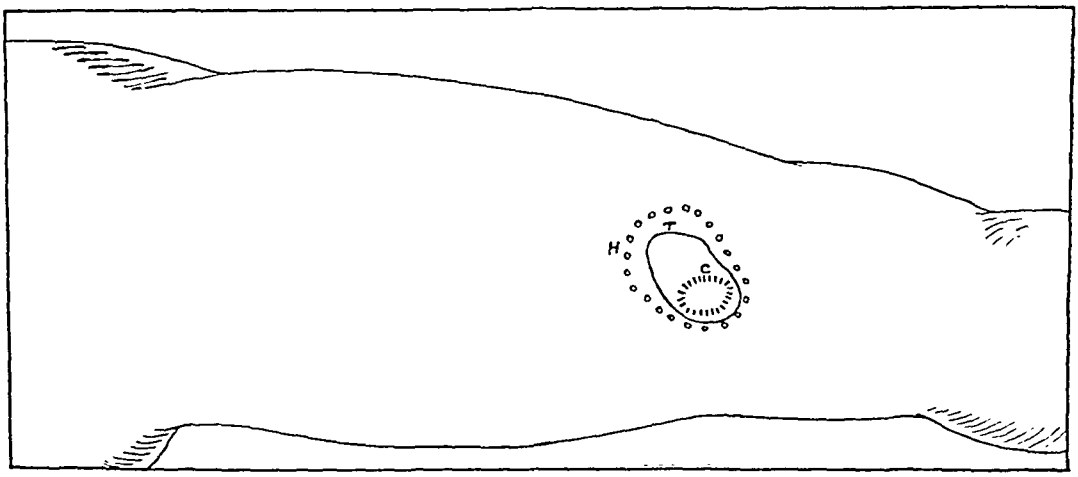


FIG. 15.—December 6, 1936: Further improvement.

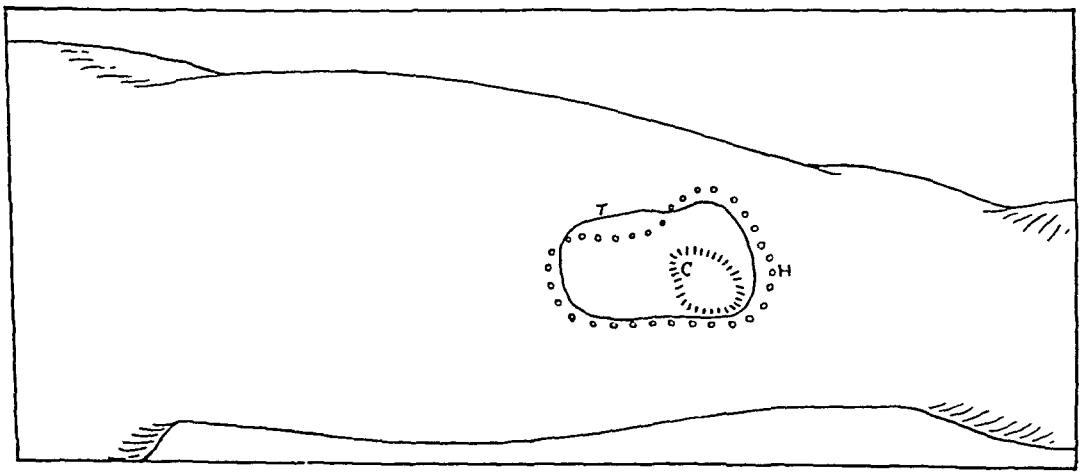


FIG. 16.—December 7, 1936: Condition temporarily worse.

Second Operation.—December 1, 1936: The chief point in the new operation was the cutting, with a rongeur, of a slot in the crest of the ilium one inch posterior to the anterior superior spine, and deeply enough so that the nerve, which was embedded in scar tissue, would be quite relaxed and would no longer be required to make a right-angled bend at the ilium. Figure 10 shows the completed operation with two pedicle fat flaps surrounding the nerve. Several interrupted silk sutures repaired the inguinal liga-

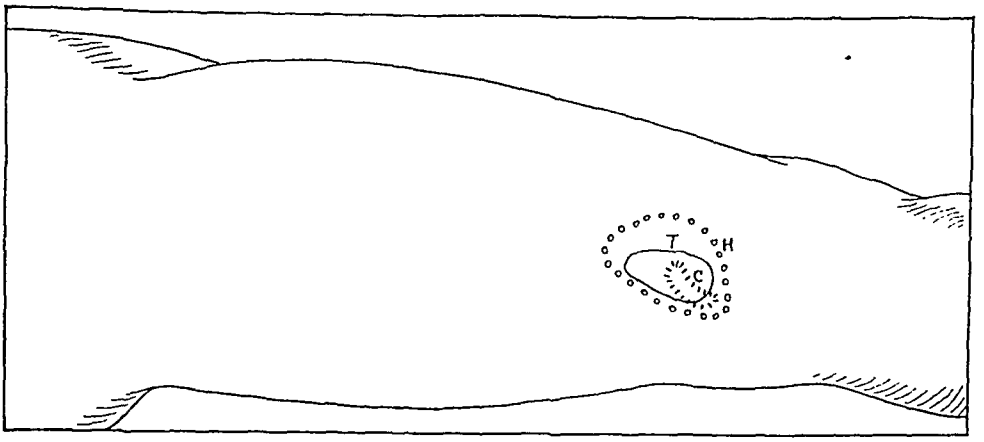


FIG. 17.—December 8, 1936: About the same as two days previously.

ment; the incision was then closed as before. A roentgenogram was taken of the ilium for a record.

Subsequent Course.—The patient was at once free of the burning pain, and the sensory improvements, day by day, are shown in Figures 12 to 17, inclusive. On the day of discharge, December 8, 1936, the two-point compass test showed the involved area to be one-half as accurate as normal skin.

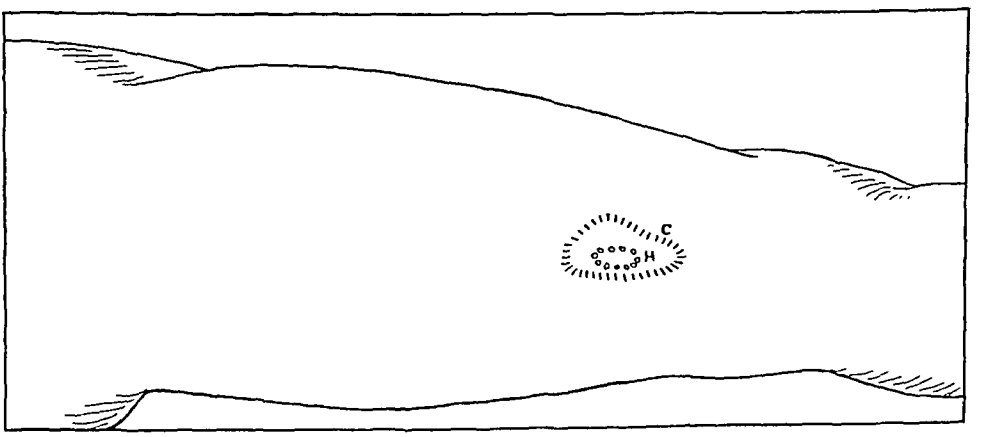


FIG. 18.—October 27, 1937: Almost complete normal sensations. Hot and cold are experienced in the above marked areas; however, the intensity of the sensation is less than normal.

He returned to work three weeks after operation, and continued to improve gradually. When examined October 27, 1937, more than 11 months after operation he was almost normal (Fig. 18).

December 11, 1938: Slightly more than two years after the second operation he was free of pain even if he hyperextended his leg. Physical examination showed that the hairs on the affected skin were about normal, and that there was no longer any sensory disturbance in skin of the previously involved area. A roentgenogram showed no change in the groove of the ilium when compared with that taken immediately after operation.

COMMENT.—Two cases of severe meralgia paresthetica have thus been relieved of their pain and have had normal sensation restored. Obviously, not much can be claimed on the basis of these two cases, but it must be remembered that severe cases of the disease are rare and that it, therefore, would take a long time to collect a sufficiently large number. That the condition is rare may be gathered from the article by Ecker and Woltman,[3] of the Mayo Clinic, who reported an incidence of all grades of severity of the condition of three in every 10,000 admissions.

The first attempt at a possible neurolysis operation was that of Neisser and Pollack,[7] in 1902, who cut the inguinal ligament over the femoral nerve; much later Learmonth,[4] in 1933, reported a very mild bilateral case which was relieved by simple neurolysis.

Why simple neurolysis cured the first patient[5, 6] (H. H.), and not the second may be explained on the basis that the first patient was large, fat, and with more slack in the nerve after neurolysis, thus allowing more opportunity for fat to surround the nerve at the ilium. However, in the second patient, whose history has been detailed above, there was very little room between the nerve and the bone after the first neurolysis operation, and it is reasonable to believe that the subsequent fibrosis again compressed the nerve. The sharp angulation of the nerve on crossing the ilium has previously been stressed by Stookey[8] as a cause for the disease; the experience gained from the second case indicates that compression of the nerve is, possibly, also a great etiologic factor.

Several objections have been raised to this new, modified neurolysis operation, which, for want of a better term, has been termed "osteoplastic." One is that the inguinal ligament must be cut at the anterior superior spine in order to transplant the nerve into its new location, and that this procedure may weaken the inguinal region enough so that a hernia may develop. In reply, it may be said that the patient whose inguinal ligament was cut has undertaken heavy manual work for over two years, beginning three weeks after operation, without any sign of a hernia or any other physical defect.

Another objection has been that the nerve in its new location may possibly be compressed by regenerating bone. This objection may be met by pointing out: (1) That the patient had a normally functioning nerve two years after operation, long after regenerating bone would have produced compression; (2) that a roentgenogram showed that bone was not filling in the slot into which nerve had been placed; and (3) that, experimentally, the radial nerve of a cat was placed in a groove of the humerus in such a manner that bone completely encircled the nerve. After allowing the hard bone to encompass the nerve for two years, it was found that the cat used the leg normally, that the nerve conducted impulses through the bone-encircled area, and that, finally, histologic sections showed the presence of axis cylinders in the nerve distal to its point of emergence from the bony canal.

Clinically, it will be recalled that a sectioned nerve shows a greater area of skin with the loss of sensation to light touch than to pin prick, whereas

a compressed nerve gives the reverse picture (Core,[2] Stopford[9, 10]). However, the sensory changes reported above do not agree with this clinical picture, because when the patient suffered the maximum of nerve compression (Fig. 1) the area of light touch (cotton wisp) anesthesia (T) was the second largest involved; and not the least, in the second place, when compression of the nerve again took place after the first operation, this area was the largest (Fig. 9), and not the smallest.

The curious overlap of sensations (Figs. 3, 4, and 5) following the first operation was not duplicated after the second interference (Figs. 12 to 17). It is possible that this overlap may be of particular interest in the study of cutaneous sensitivity in that it may be diagnostic of nerve compression.

CONCLUSIONS

This report proposes to make two contributions to the understanding of meralgia paresthetica:

(1) The cause of the disease is probably a compression of, and tension on, the lateral femoral cutaneous nerve as it passes under the inguinal ligament, because in the three instances in which neurolysis was performed on this nerve in that location there resulted an immediate and progressively favorable increase in the sensibility of the skin supplied by the nerve.

(2) A cure for the disease may be a modified neurolysis operation, by means of which pressure and tension are taken from the nerve, which is then relocated in a slot in the ilium.

In two severe cases, one of which is reported in detail here, the patients were entirely relieved of their symptoms, and had normal sensation restored in the skin. The first patient has been well now over four years, and the second was well when examined two years after the second operation.

BIBLIOGRAPHY

[1] Bramwell, E.: A Case of Meralgia Paresthetica (Bernhardt's Sensiblitäts störung). With a Short Account of the Condition. Edinburgh Med. Jour., 14, 26–33, 1903.

[2] Core, Donald E.: The Dissociation of Cutaneous Sensations in Injuries to Peripheral Nerves. Lancet, 1, 716–718, 1916.

[3] Ecker, Arthur D., and Woltman, Henry W.: Meralgia Paresthetica. A Report of 150 Cases. J.A.M.A., 110, 1650–1652, 1938.

[4] Learmonth, James R.: The Principle of Decompression in the Treatment of Certain Diseases of Peripheral Nerves. Surg. Clin. N. Amer., 13, 905-913, 1933.

[5] Lee, Ferdinand C.: Meralgia Paresthetica. Internat. Clinics, 1, 46th series, 210–230, 1936.

[6] Lee, Ferdinand C.: A Preliminary Report on an Operation for the Cure of Meralgia Paresthetica. Bull. Johns Hopkins Hosp., 64, 147–148, 1939.

[7] Neisser, Ernst, and Pollack, Curt: Beitrag zur Kenntniss der Roth-Bernhardt'schen Meralgie und ihrer Operativen Behandlung. Mitt. a. d. Grenz. d. Med. u. Chir., 10, 453–461, 1902.

[8] Stookey, Byron: Meralgia Paresthetica. Etiology and Surgical Treatment. J.A.M.A., 90, 1705–1707, 1928.

[9] Stopford, John S. B.: Gunshot Injuries of the Peripheral Nerves: The Syndrome of Compression. Lancet, 1, 718-721, 1916.

[10] Stopford, John S. B.: Compression of Nerve Fibers. Brit. Med. Jour., 1, 1028–1029, 1926.

EXTRASKELETAL OSSIFYING TUMORS

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MESOBLASTIC TUMORS containing bone occur which have no connection with the skeleton. In all probability many more such tumors have been reported than have been revealed in this search of the literature because of failure of the authors to indicate the presence of bone in the title of the article.

The presence of calcification and ossification in old hematomata is not an unusual pathologic finding. Other examples of heterotopic bone, not infrequently seen, are ossification in the arteries, heart valves, pericardium and in old tuberculous foci. There are numerous instances of heterotopic bone formation in old abdominal cicatrices. Myositis ossificans is usually continuous with the skeletal system though there may be no connection, as when it involves muscles of the abdominal wall after celiotomy.

In addition to the heterotopic bone formations mentioned above, ossification may occur in neoplasms having no skeletal connection. When the tumor is epithelial in origin, as in the case of carcinoma of the breast, the bone is heteroplastic in nature, coming from the connective tissue.

Ossification of intracranial neoplasms, not arising from the skull, has been observed many times. Alpers[1] reports an osteochondroma arising from the dura and cites two cases by other authors of similar tumors. He also cites four intracranial chondromata not related to the skull.

Sperling and Alpers[33] report an osteolipoma of the brain and record 12 other cases of this type from the literature.

Examples of benign bone tumors in the soft parts in areas other than the brain are also found. An osteoma of the tongue was reported by Magnien and Perrot,[24] and an osteoma of the breast by Roffo and Meabe.[28] Recently, a perirenal retroperitoneal osteoma was reported by Kretschmer.[21]

Jacobson[18] reported two instances of ossifying tumors of the soft parts which, histologically, resembled benign giant cell tumors of bone. In one case, the tumor developed in the thigh, while in the other instance it was found in the popliteal space. Neither tumor was considered malignant clinically or histologically.

The author agrees with Jacobson in believing that since by metaplasia the connective tissue cell may form bone, then it is natural to assume that all types of bone tumors might occur in the soft parts.

Recently, two osteogenic sarcomata, experimentally produced in the soft parts of rats, were reported by Dunning, Curtis and Bullock.[11] These workers injected 1–2 benzopyrine subcutaneously into a group of 842 rats. Various types of tumors resulted. The two osteogenic sarcomata resembled malignant

Submitted for publication July 27, 1939.

primary bone tumors although they developed in the soft tissues. Brunschwig and Roome[5] report having produced a spindle cell sarcoma in the left suprarenal gland of a rat by the implantation of crystals of methylcholanthrine into this organ. Sections revealed scattered small areas showing ossification of the intramembranous type.

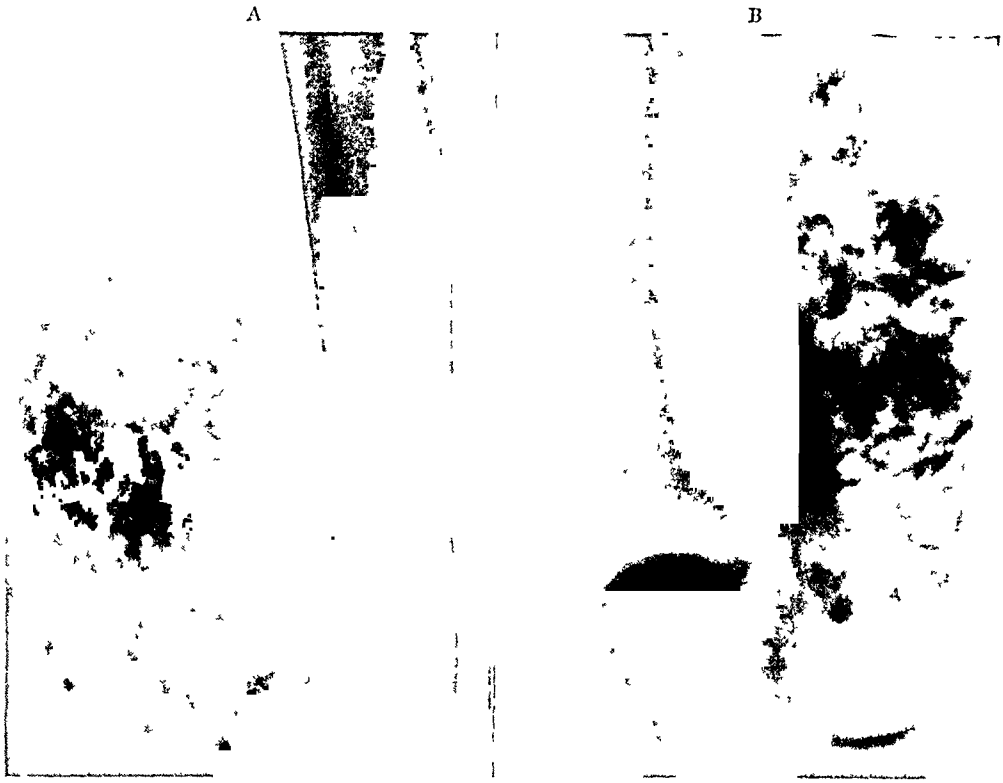


FIG 1.—Case 1 A and B Roentgenograms of supracubital region showing extraskeletal oval tumor containing irregular areas of bony density.

Thirty cases of bone-forming malignant tumors in the soft parts were reviewed from the literature (Table I). The histologic report given in most of these cases was compatible with that of a true osteogenic sarcoma. Not all of this group were studied roentgenologically. These tumors occurred at various sites in the body—in the extremities, abdominal wall and viscera, breast and thyroid.

The present study consists of ten cases of extraskeletal ossifying tumors collected from the departments of surgery and pathology of the University of Chicago and from the Bone Sarcoma Registry of the American College of Surgeons.

CASE REPORTS

Case 1.—Bone Sarcoma Registry No 2033: Case of Dr. T. R Ross. J. C., male, age 35.

History and Physical.—C. C.: Tumor of arm just above elbow. P. I.: Patient struck left elbow against an object in December, 1936. The pain and swelling following the injury were somewhat relieved by hot dressings.

Roentgenologic examination March 3, 1937, revealed a large oval-shaped mass above the cubital fossa. Scattered throughout the mass were areas of bony density (Fig. 1 A and B). *Roentgenologic Diagnosis:* Calcified hematoma.

TABLE I

SYNOPSIS OF 30 CASES OF BONE-FORMING MALIGNANT TUMORS IN THE SOFT TISSUES

(From the Literature)

Author	Patient and Complaint	Essential Characteristics of Lesion
1. Arnold[2]	Woman, age 67. Goose-egg-size tumor of nipple for 6 mos.	Spindle and giant cells. Islands of cartilage and of osteoid tissue. No mention of metastases. No follow-up after operation. Diagnosis: Osteochondrosarcoma of breast.
2. Bianchi[3]	Woman, age 60. Tumor in right quadrant of abdomen. No jaundice.	At operation, a malignant tumor of gallbladder was removed. Gallbladder contained stones. Tumor arising from fundus showed spindle cells and osteoid tissue and calcification. Numerous mitotic figures. Diagnosis: Osteogenic sarcoma of gallbladder.
3. Broders and Pemberton[4]	Woman, age 71. Growth in right side of neck for 4 mos.	Biopsy. Pleomorphic and spindle cells. Areas of osteoid and tumor bone present. Radium needles inserted. Patient eventually died of sarcoma. Diagnosis: Osteogenic sarcoma of thyroid.
4. Budd and Breslin[6]	Woman, age 59. Lump in chest wall above breast for 28 yrs. Rapid growth for past year.	No x-ray. Hard tumor calcified in some areas. Microscopic: Some areas showed carcinoma cells with alveolar structure. Other areas contained spindle cells, osteoid tissue and bone. One type of tissue merged with the other. Numerous mitotic figures. Diagnosis: Carcino-osteogenic sarcoma of chest wall.
5. Busser[7]	Woman, age 50. Radical mastectomy. Recurrence 2 yrs. later.	Microscopic at first operation showed adenofibroma with some osteoblasts and chondroblasts at the periphery. Recurrence of nodule in scar 2 yrs. later. Immature cells, rapidly growing. Chondroblasts and osteoblasts. Osteoid tissue. Definitely malignant. Diagnosis: Osteochondrosarcoma of breast.
6. Butler and Woolley[8]	Woman, age 68. Tumor, left thigh; 11 yrs. before bruised leg at this site and some swelling had persisted.	X-ray: Soft tissue mass 9x5 cm. Periphery of mass showed areas of irregular calcification suggestive of an "old calcified hematoma." Tumor excised 20x12x10 cm. Microscopic: Round and spindle cells, mitotic figures, some calcium and some true bone. Chest metastases present by x-ray. Died 2 yrs. after onset. No autopsy. Diagnosis: Osteogenic sarcoma arising from calcified hematoma.
7. Caën[9]	Woman, age 59. "Tumor of breast, size of child's head."	Hyalin cartilage and bone present. Diagnosis: Osteochondrosarcoma.
8. Chavannaz and Pierre-Nadal[10]	Woman, age 74. Tumor of thyroid present several years; rapid growth for 2 mos.	Tumor composed of spindle cells, cartilage and bone. Diagnosis: Osteogenic sarcoma of thyroid.
9. Ferrero[12]	Woman, age 29. Tumor of abdominal wall for 2 mos.	Tumor size of "hen's" egg, excised from lower abdominal wall. Recurred and radical excision performed. Microscopic: Very cellular—round, oval and spindle cells. Interlacing trabeculae of bone and osteoid tissue. Diagnosis: Sarcoma.
10. Foerster[13]	Woman, age 60. Tumor of thyroid. Duration not given.	Spindle cells; bone present in tumor. No metastases. Diagnosis: Osteogenic sarcoma of thyroid.
11. Funkenstein[14]	Tumor of thyroid.	Spindle cells. Bone present. No metastases. Diagnosis: Osteogenic sarcoma.
12. Funkenstein[14]		Similar to above case.
13. Gomori[15]	Woman, age 64. Painless lump in right breast for 6 mos. Size of "baby's head"; ulceration.	Simple mastectomy and resection of axillary nodes. Spindle cells, giant cells, mitotic figures, bony trabeculae present. Diagnosis: Osteochondrosarcoma of breast.
14. Haining and Poole[17]	Man, age 76. Hematuria; mass in left kidney region.	Autopsy: Tumor of left kidney which, histologically, was said to be identical with osteogenic sarcoma. Spindle, round and giant cells present. Osteoid tissue and bone. Widespread metastases. Some metastases contained bone.
15. Jaidka[19]	Boy, age 14. Pain and stiffness in right thigh for 6 wks. Tumor in vastus externus.	Hip joint disarticulation. Malignant tumor of fibrous tissue origin present producing bone. Diagnosis: Ossifying sarcoma of vastus externus muscle.

TABLE I (*Continued*)

Author	Patient and Complaint	Essential Characteristics of Lesion
16. Kreibig[20]	Woman, age 50. "Walnut size tumor of breast."	Giant cells, cartilage, osteoid tissue and bone. Diagnosis: Osteosarcocarcinoma of breast.
17. Kubo[22]	Man, age 39. Tumor right side of abdomen.	G. I. x-ray only. Explored: Tumor "size of head" adherent to bowel and peritoneum. Lymph node biopsy showed *fibrosarcoma*. Autopsy (55 days later): Osteofibrosarcoma of mesentery. Large areas of bone. Some myxomatous tissue.
18. Kurosu[23]	Woman, age 60. "Head-sized tumor" of breast; duration not given.	Died soon after excision. Diagnosis: Osteochondro-angiosarcoma. No autopsy.
19. Mallory[25]	Woman, age 55. Breast tumor; for 3 mos.	Excised. No recurrence in 1 yr. Spindle cells, tumor giant cells. Osteoid tissue, some calcification. Believed to be a sarcoma.
20. Mallory[25]	Woman, age 65. Tumor left thigh; for 2 yrs.	Tumor excised. Recurred. Microscopic: Composed of spindle cells. Tumor giant cells present. Bone trabeculae. Frankly neoplastic process. Bone probably heterotopic, possibly neoplastic. Diagnosis: Sarcoma of thigh containing bone.
21. Pick[26]	Woman, age 51. Tumor of neck, present for several years. Developed tumor of palate and died soon after.	Tumor of neck was sarcoma in thyroid. Mass made up of spindle cells. Bone present in many areas. Widespread metastases. Lung metastases contained bone. No autopsy.
22. Rhoads and Blumgart[27]	Woman, age 21. Lump in right thigh, for 5 wks.	Encapsulated tumor not connected with thigh. Microscopic: Spindle cells, mitoses, osteoid changing into bone. Well 10 yrs. later. Diagnosis: Osteoblastoma.
23. Rhoads and Blumgart[27]	Male, age 37. Swelling in left groin, for 15 mos.	Left inner thigh firm, rounded mass 2x6 cm. X-ray: Calcium density in region of tumor. Microscopic: Immature fibroblasts, many mitoses, new bone, osteoid tissue and cartilage. Well 7 yrs. after excision. Diagnosis: Osteoblastoma.
24. Sailer[29]	Woman, age 59. Lump in right breast, for 6 wks.	Tumor present 4x3 cm. Microscopic: Spindle round cells. Many mitoses. Spicules of bone surrounded by osteoblasts. Osteoid and cartilage present. Well 2 yrs. later. Diagnosis: Sarcoma of breast (osteogenic).
25. Sehrt[31]	Woman, age 44. "Fist-sized" tumor of breast, for 6 mos.	Excised. Microscopic: Giant cells, cartilage, osteoid and bone present. Appearance of bone varied considerably in various areas of tumor. No mention of metastases. No follow-up. Diagnosis: Osteosarcoma of breast.
26. Stilling[34]	Woman, age 53. Large breast tumor. Duration not given.	Osteoid tissue, cartilage and bone in tumor. Metastases to lungs. Diagnosis: Osteosarcoma of breast.
27. Stilling[34]	Woman, age 59. Tumor of breast.	Osteoid tissue and cartilage, spindle and giant cells. Local recurrence 5 wks. after excision. Metastases to distant foci. Diagnosis: Osteosarcoma of breast.
28. Solaro[32]	Male, age 46. Tumor of thyroid region, for 8 mos.	Spindle cell sarcoma of thyroid contained much bone and cartilage. Bony tissue appeared to be rather normally formed. Recurred 2 mos. after operation. Diagnosis: Sarcoma of thyroid (osteogenic).
29. von Hacker[35]	Woman, age 50. Small tumor of left breast, for 20 yrs. Rapid growth for 1 mo.	Cartilage, bone, fibrous tissue and osteoid tissue. Believed to be carcinoma containing bone.
30. Williams[36]	Woman, age 53. Tumor in calf muscles, for 10 mos.	Hard tumor in gastrocnemius. X-ray: Irregular shadow of calcium density. Partially encapsulated at operation. Arose from fascial plane between gastrocnemius and soleus. Diagnosis: Round cell sarcoma forming new bone.

Operation was performed March 15, 1937, and an irregular mass, 8 cm. in diameter, was removed.

On July 29, 1937, a recurrence of the tumor, 4 cm. in diameter, was excised and on October 27, 1937, because of a second recurrence, a shoulder disarticulation was performed.

Pathologic Examination.—Gross: Tissue from first operation. The tissue varies in consistency. Portions of tumor are fibrous and myxomatous, while other areas resemble cartilage. Some areas are calcified.

Microscopic.—The tumor in some areas is quite cellular. The cells are small and have spindle-shaped nuclei. Occasional mitotic figures are seen. Small fat cells are also

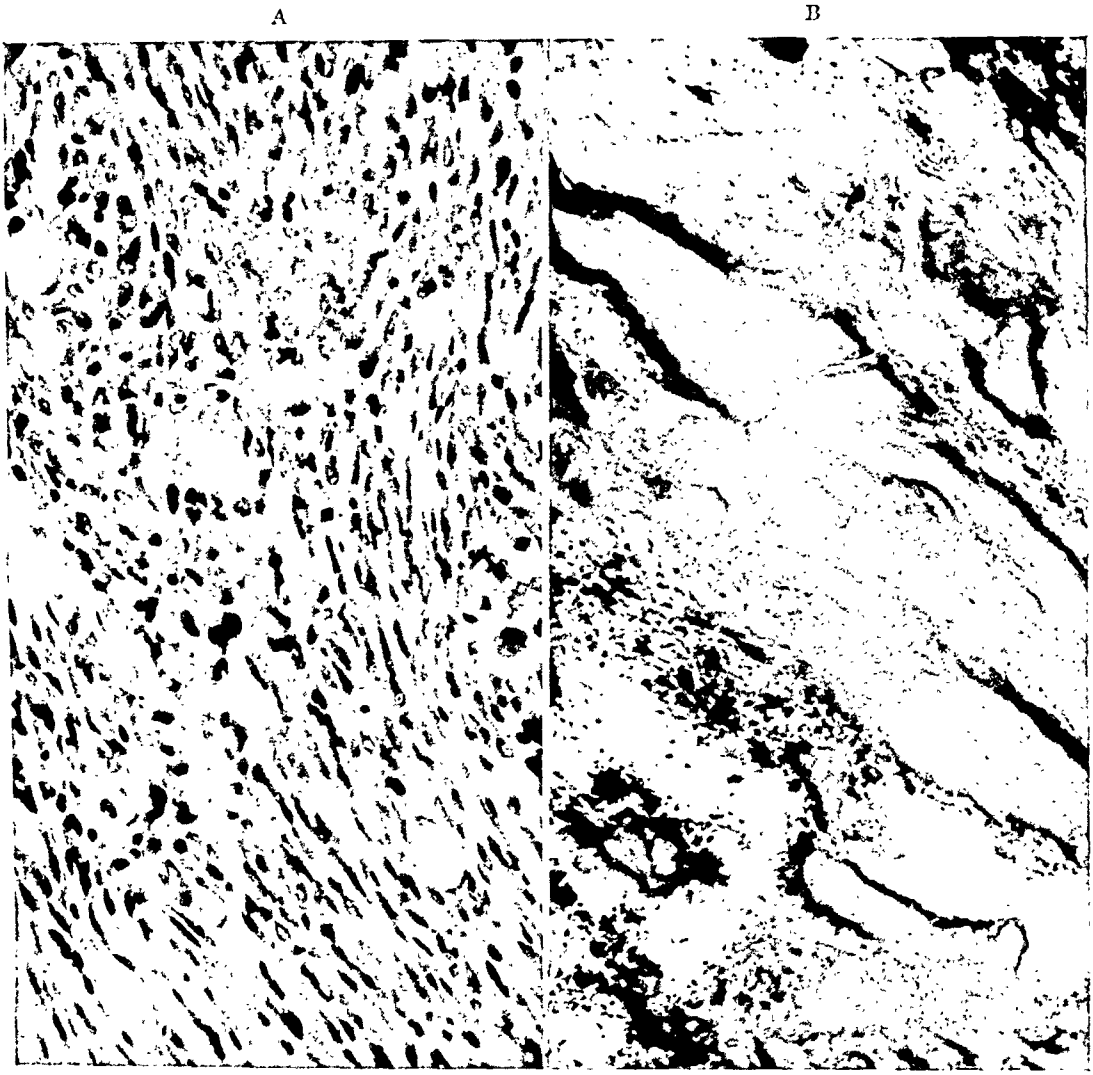


FIG. 2.—Case 1: Microscopic appearance of the tumor. (A) Soft portion. (B) Calcified and ossified portion.

present (Fig. 2 A). In other portions of the tumor large irregular areas of calcification are present and immature cartilage cells are seen. Ossification is occurring in some areas; however, it is difficult to determine from the histologic appearance whether this represents heteroplastic or neoplastic bone formation (Fig. 2 B).

Tissue from the first and second recurrences of tumor show invasion of surrounding muscles. Microscopic examination of the tumor recurrences reveals closely packed cells varying considerably in form and showing more evidence of malignancy as judged by the frequency of mitotic figures and the invasion of muscle. *Pathologic Diagnosis:* Osteogenic sarcoma, extraskeletal.

Case 2.—Bone Sarcoma Registry No. 1396: Registered by Dr. B. L. Coley. S. M., female, age 61, admitted to Memorial Hospital, N. Y., September 8, 1931.

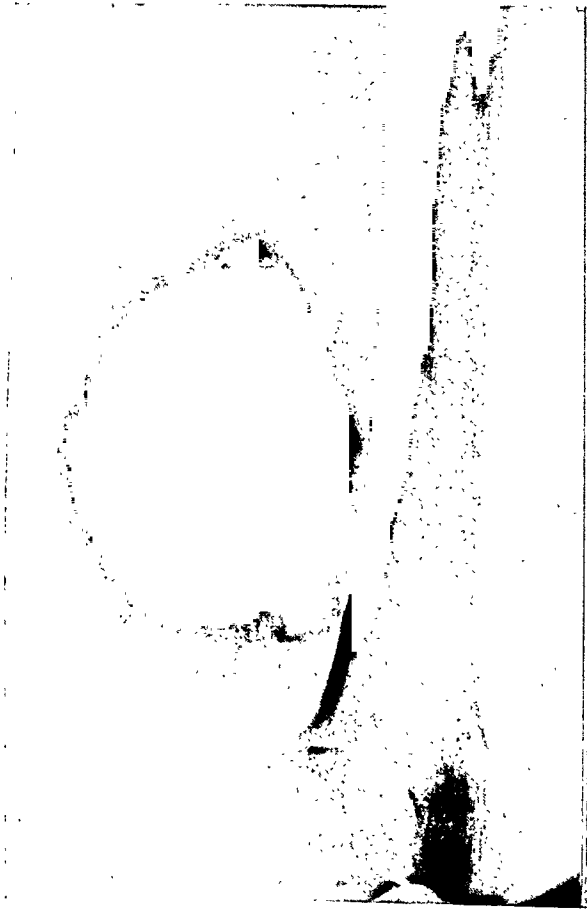


FIG. 3.—Case 2: Roentgenogram of extraskeletal tumor of bony density in mesial aspect of thigh.

A

B

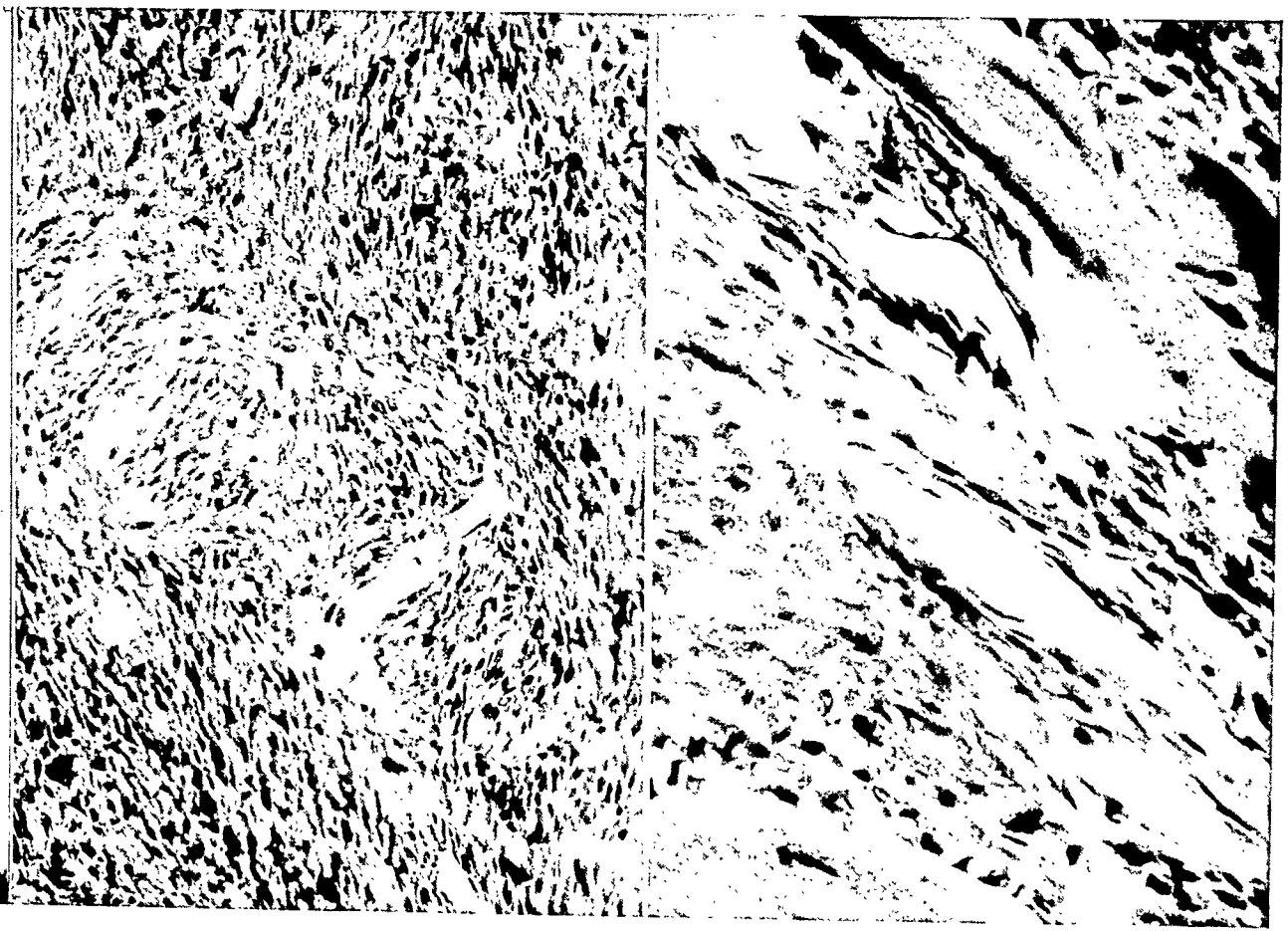


FIG. 4.—Case 2: Microscopic appearance of the tumor. (A) Unossified portion. (B) Ossified portion.

History and Physical.—C. C.: Tumor of left thigh. Ten years previously a slow growing tumor first appeared on the lower inner aspect of the left thigh. Excision was done one year after tumor was first noted.

Subsequent Course.—Two and one-half years before hospital admission a rapidly growing recurrent tumor developed, which was the size of a grapefruit when patient was examined.

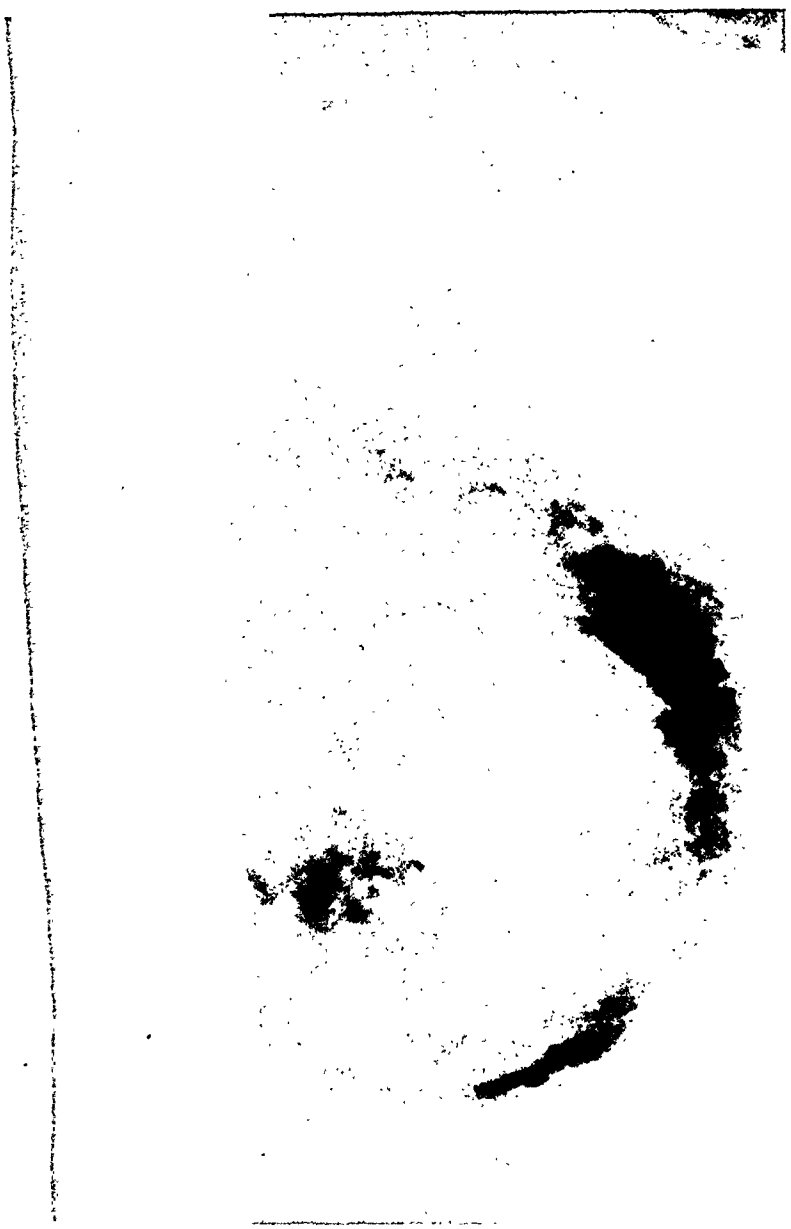


FIG. 5.—Case 3: Roentgenogram of extraskeletal tumor of mesial side of thigh casting shadow of calcium density in its peripheral portion.

Roentgenologic examination showed a large mass of bony density in the lower inner aspect of the left thigh. There was slight radiation at the periphery of the dense shadow.

The tumor was excised July 18, 1931, and diagnosed osteogenic sarcoma. The wound never healed properly. Roentgenotherapy was given and, on February 20, 1932, the leg was amputated. Death occurred two days later.

Microscopic Examination.—The tumor consists mainly of spindle cells growing in whorls and in irregular clumps. Some large giant cells are present. Many cells are

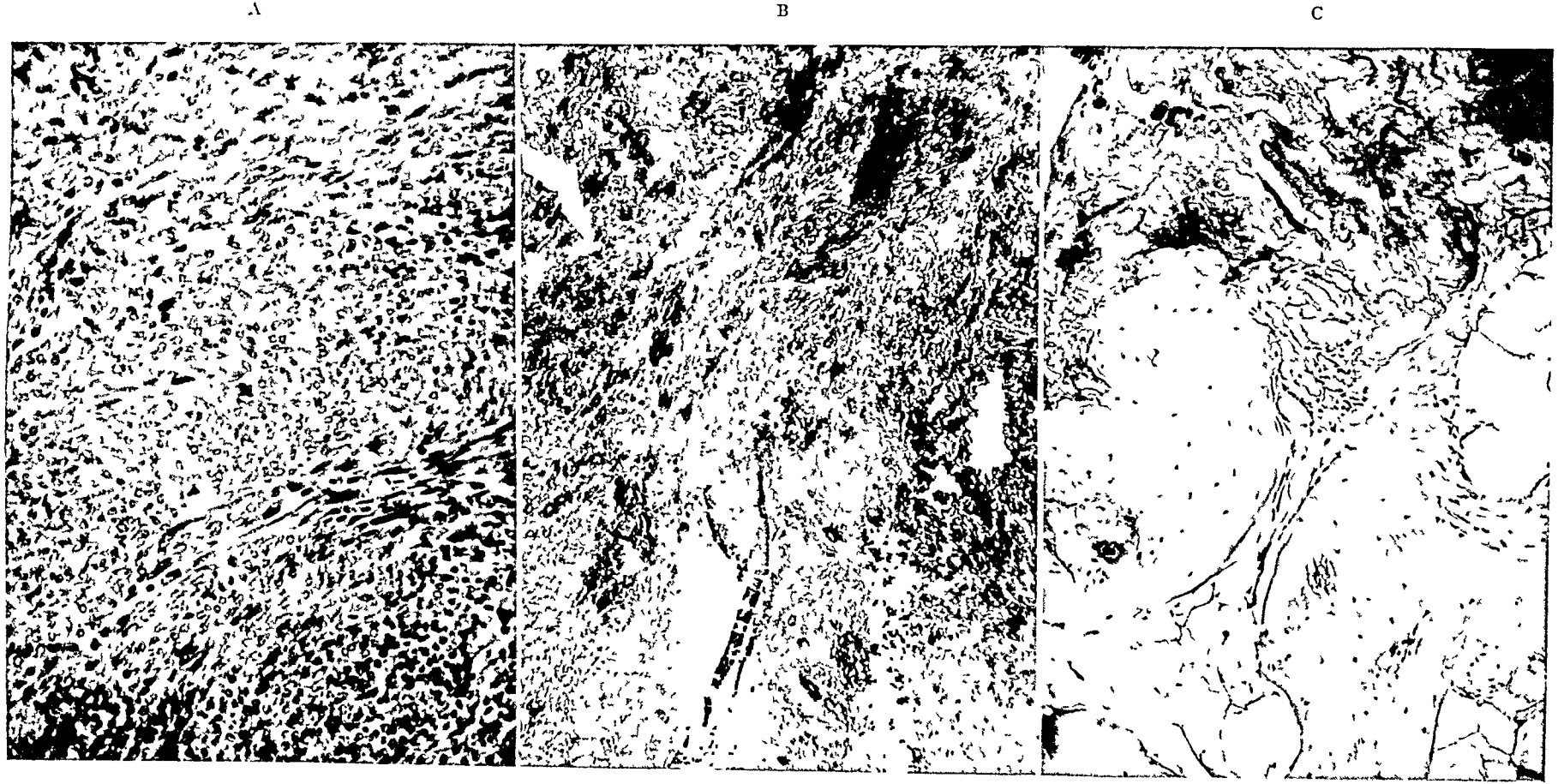


FIG 6.—Case 3 Microscopic appearance of the tumor (A) Soft portion (B) Calcified portion (C) Calcified and ossified portion

undergoing mitotic division. There are irregular trabeculae of neoplastic osteoid tissue scattered about the section and small islands of atypically appearing bone. *Pathologic Diagnosis:* Osteogenic sarcoma, extraskeletal.

Case 3.—Bone Sarcoma Registry No. 2051: Case of Dr. Alexander Brunschwig. N. G., female, age 25.

History and Physical.—Swelling in left thigh of nine months' duration. Examination showed an enlargement extending from the buttock to the middle third of the thigh involving chiefly its posterior mesial aspect.

Roentgenologic examination revealed a soft tissue swelling which contained areas of bony density (Fig. 5).



FIG. 7.—Case 4: Roentgenograms showing islands of bony density in extraskeletal tumor.

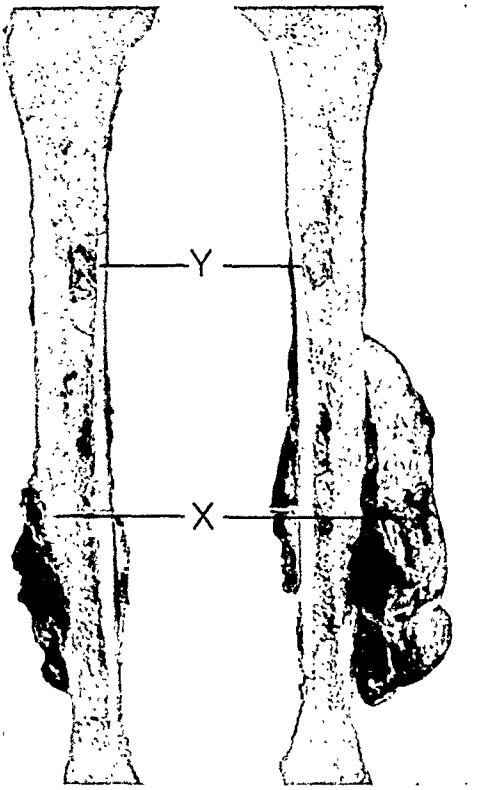


FIG. 8.—Case 4: Extraskeletal sarcoma of soft tissue of leg with secondary erosion of tibia and invasion of (X), and metastasis in (Y) medulla.

Biopsy was performed May 30, 1936, following which 8,000 r units of roentgenotherapy were administered. A second biopsy was taken after the roentgenotherapy.

Pathologic Examination.—Microscopic: Sections of tissue removed on both occasions reveal a preponderance of spindle cells arranged in whorls and bundles. Mitotic figures are present. There are irregular areas of calcification and in some of these areas bone has formed (Fig. 6). *Pathologic Diagnosis:* Fibrosarcoma with degeneration, calcification and heteroplastic bone formation.

Case 4.—Case of Dr. Dean Lewis: M. E. P., male, age 34, admitted to Presbyterian Hospital, Chicago, May 30, 1916.

History and Physical.—C. C.: Tumor of left leg. A hard nodule appeared above the external malleolus 12 years before admission; however, during the 18 months prior to admission growth of the tumor was much more rapid. Examination revealed a mass 17x7x4 cm. on the anterior surface of the left leg (Fig. 7). Amputation was performed above the knee.

Pathologic Examination.—Gross: The tumor is irregular in contour and can be easily lifted away from the tibia, suggesting that it arose outside the bone (Fig. 8).

Microscopic.—The tumor in some areas is quite cellular and in others contains a large amount of collagen. The majority of the cells are oval or rounded in shape and mitotic figures are numerous. Many giant cells are present. Throughout the tumor are small areas exhibiting calcification and ossification. *Pathologic Diagnosis:* Extraskeletal sarcoma with bone formation. The patient subsequently died of metastases.

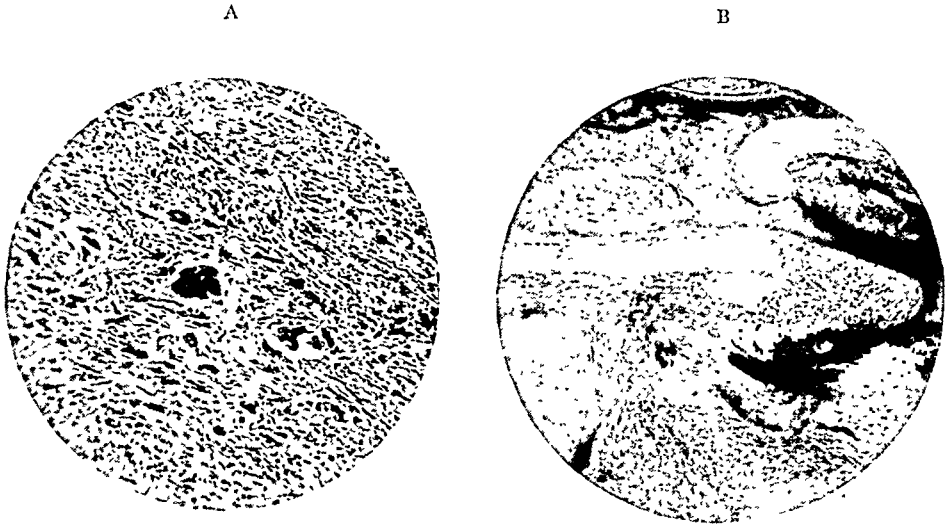


FIG. 9.—Case 4: Microscopic appearance of the tumor. (A) Unossified portion. (×170) (B) Ossified portion. (×110)

Case 5.—Bone Sarcoma Registry No. 1494: Registered by Dr. B. L. Coley. R. M., male, age 19.

History and Physical.—Patient entered Memorial Hospital, New York, September 9, 1932, because of swelling of the face, neck and right arm and right leg of four days' duration.

Roentgenologic examination revealed a large oval shadow of bony density in the left mediastinum and adjacent lung field. The edges of this were somewhat irregular (Fig. 10). Death occurred November 12, 1932.

Necropsy revealed a large tumor in the mediastinum about the base of the heart. It consisted chiefly of dense bone but showed some areas of cartilage. Metastases were found in the brain, pancreas, kidney and lungs.

Microscopic Examination.—The tumor contains interlacing bundles of wildly growing spindle cells. In some areas there are sheets of irregular neoplastic osteoid tissue. Very atypical new bone is found associated with the osteoid tissue (Fig. 11). *Pathologic Diagnosis:* Osteogenic sarcoma, extraskeletal.

Case 6.—Bone Sarcoma Registry No. 2131: Case of Dr. Philip Lewin. M. S., female, age 28.

History and Physical.—Pain in left gluteal region began in December, 1936, and one month later swelling was also noted in this area. In October, 1937, a longitudinal fusiform mass, 6 cm. in its greatest diameter, was present in the gluteal region. A roentgenogram revealed a soft tissue mass with blotchy areas of increased density showing calcification (Fig. 12).

The mass was excised by Doctor Lewin October 19, 1937, at the Michael Reese Hospital, Chicago. The greater portion of the tumor was soft, in some areas having a

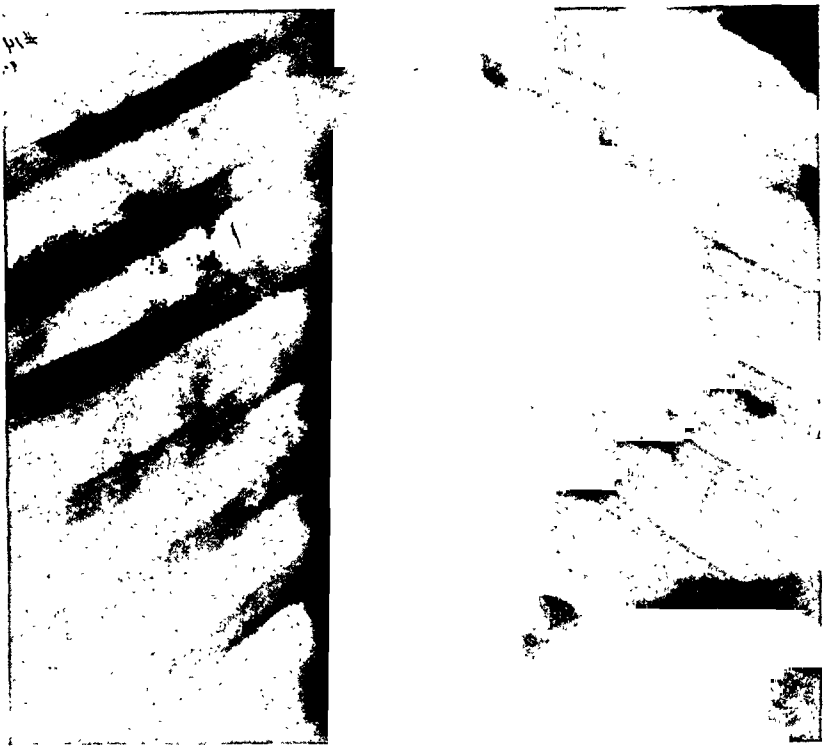


FIG. 10.—Case 5: Roentgenogram showing the sarcoma casting an oval shadow of bony density in the left mediastinum.

A B

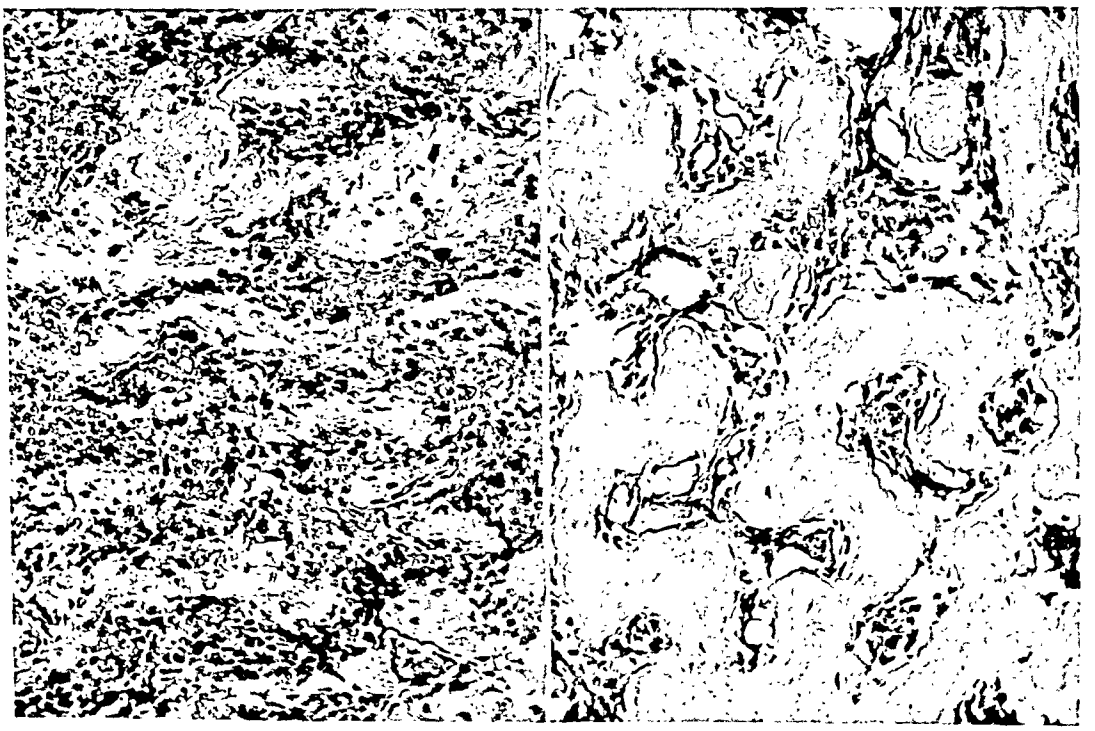


FIG. 11.—Case 5: Microscopic appearance of the tumor showing (A) Round and spindle cells and osteoid tissue. (B) Trabeculated bone.



FIG 12.—Case 6 Roentgenogram showing the chondrosarcoma of gluteal region with blotchy areas of calcium density

A B

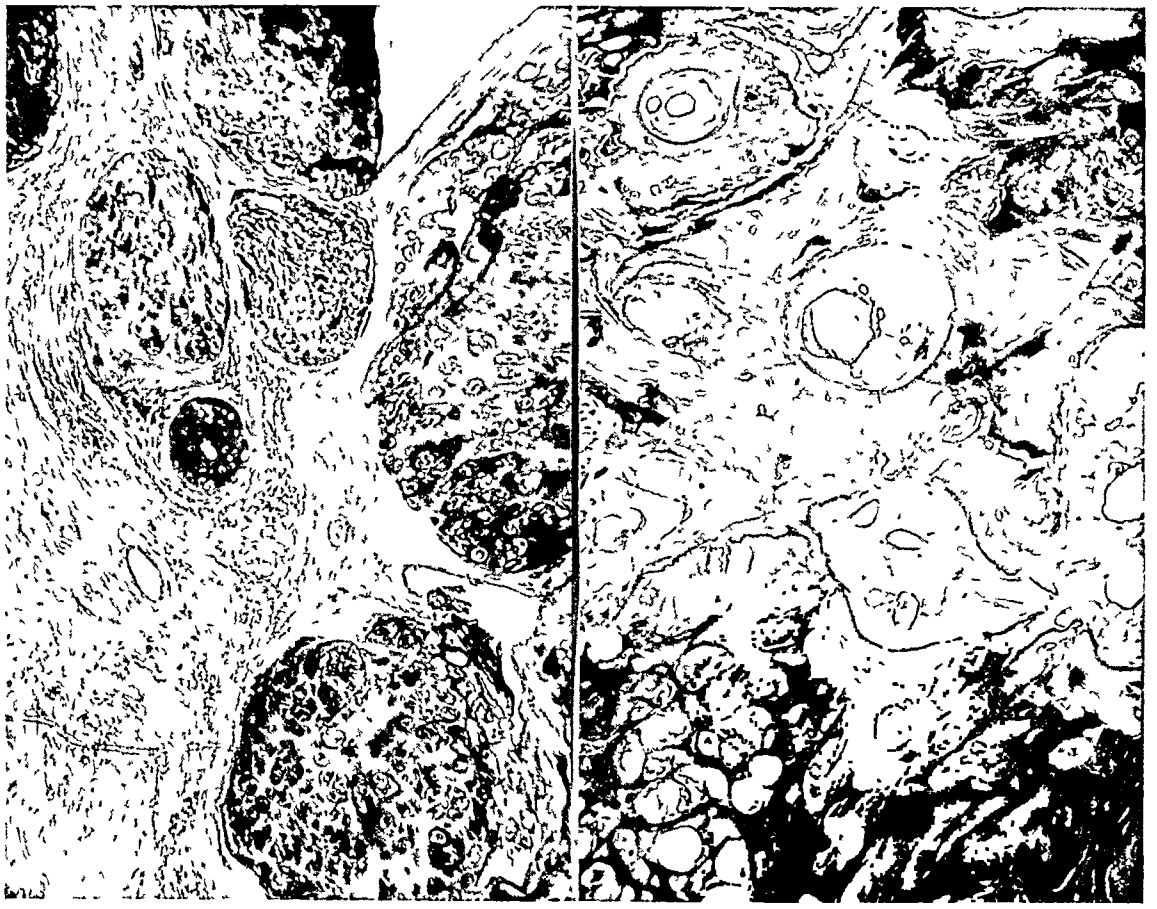


FIG 13.—Case 6 Microscopic appearance of the tumor showing (A) Cartilaginous nodules about periphery (B) Ossified and calcified portion

gelatinous character, while in other areas its consistency was that of bone. Over a small area the tumor was in contact with the ilium. Roentgenotherapy was given after the operation.

Pathologic Examination.—Microscopic: Sections reveal a rather varied appearance. The tumor is composed mainly of cartilage and the large cartilaginous islands are surrounded by dense fibrous tissue. The cartilage cells vary greatly in size and arrangement. Calcification is present in some areas and bone formation is also seen (Fig. 13 A and B). Large myxomatous areas are present which merge into masses of immature cartilage cells. *Pathologic Diagnosis:* Chondrosarcoma, extraskeletal.

On April 16, 1939, a roentgenogram revealed a recurrent mass, calcification being noted in this mass also. Operation was refused.

Case 7.—Bone Sarcoma Registry No. 2055: Case of Dr. C. Howard Hatcher. P. P., male, age 29, entered the University of Chicago Clinics, August 7, 1936.

History and Physical.—Eighteen months before admission pain was noticed in the right hip. This increased greatly in severity and radiated down the leg. Examination revealed a mass, 4x4 cm., in the region of the greater trochanter. Tenderness was also noted in this area. Roentgenograms revealed a soft tissue mass containing areas of bony density in the region of the right hip. There was no connection between the increased density of the tumor and the pelvis (Fig. 14).

On August 12, 1936, a mass, 10x10x8 cm., was excised from an area which involved the deep fascia overlying the gluteus medius midway between the greater trochanter and the ilium. Grossly, the tumor was made up of firm fibrous tissue containing some calcified areas.

Pathologic Examination.—Microscopic: Section reveals large areas of closely packed fibrous tissue cells. The fibrous tissue cells are growing in interlacing strands and bundles. Throughout the fibrous tissue are numerous clumps of deeper staining cells with round or oval nuclei having a rather indefinite cytoplasmic outline. Numerous mitotic figures are seen. In a few areas these cells form papillary-like structures suggestive of epithelial origin. Some small areas of calcification are undergoing ossification. There are also some large mature bone islands, the bone apparently having been formed by the intramembranous method. Muscle invasion by the tumor is seen in some areas (Fig. 15 A and B). *Pathologic Diagnosis:* Bursal sarcoma with ossification in primary tumor.

Subsequent Course.—Roentgenotherapy was given after operation and following this the patient was lost sight of until September, 1937. At this time he complained of more pain, hemoptysis and loss of weight. Roentgenograms showed metastatic lesions in the chest and osteoclastic lesions in the left ilium, left femur and before death occurred on January 28, 1938, lesions were also demonstrated in the lumbar spine (Fig. 16).

Autopsy.—Dr. N. B. Friedman: Revealed metastasis to the right peri-iliac and peri-aortic nodes, right iliopsoas muscle, right ureter, urinary bladder, kidneys, thyroid, liver, heart, spleen, lungs and bones.

Pathologic Examination.—Microscopic: A large section made through the lumbar vertebrae showed them to be extensively eroded by tumor, and a bony bridge consisting of tumor and bony trabeculae joined the second, third and fourth lumbar vertebrae. The metastatic tumor in other areas showed no evidence of bone formation. *Pathologic Diagnosis:* Sarcoma of gluteal region, possibly of bursal origin, with ossification in the primary tumor.

Case 8.—Case of Dr. Alexander Brunschwig: W. P., male, age 20, entered University of Chicago Clinics, March 3, 1937.

History and Physical.—C. C.: (1) Swelling of left forearm for ten years. (2) Multiple soft tumors over torso and extremities for 11 years. (3) Coffee-colored plaques over torso and extremities for 11 years.

Examination revealed small masses located along the course of peripheral nerves



FIG. 14.—Case 7: Roentgenogram showing the sarcoma of the right gluteal region casting shadows of bony density.

A B

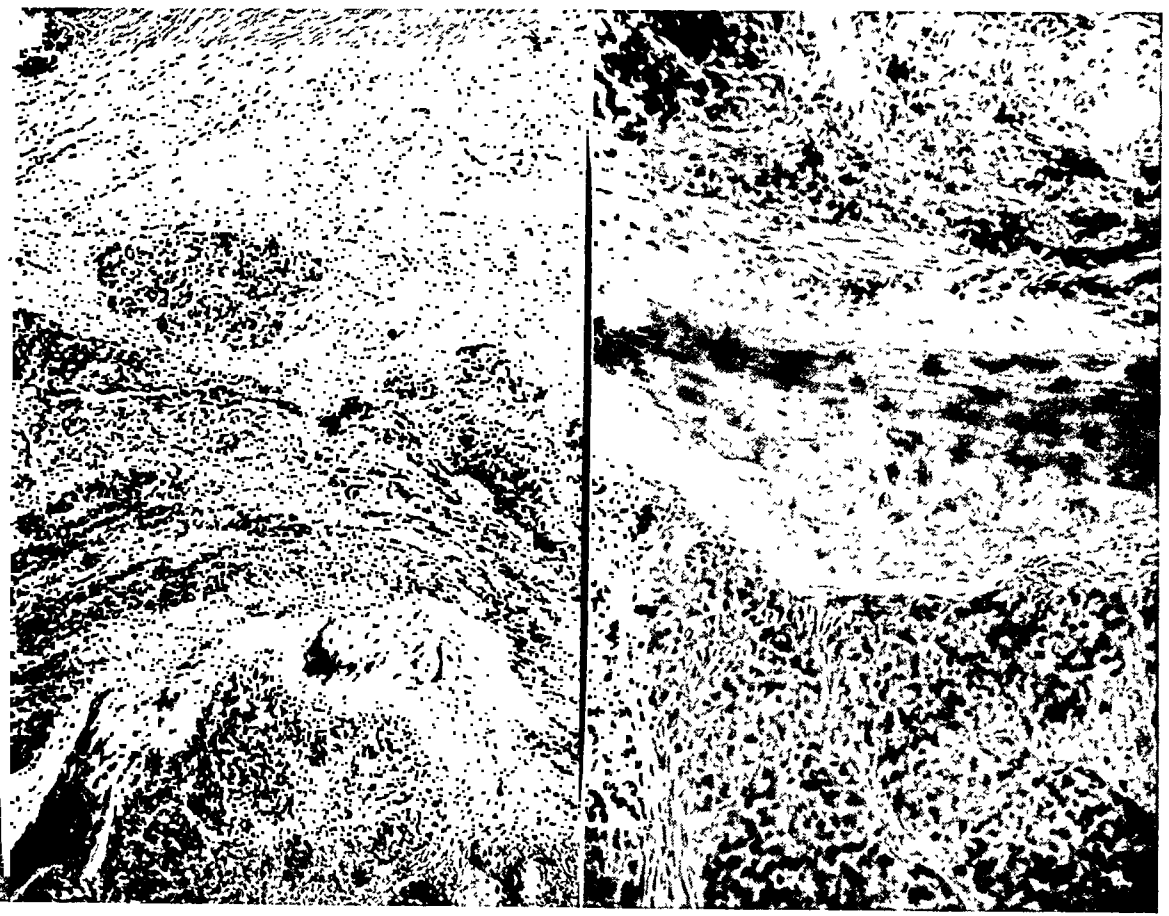


FIG. 15.—Case 7: (A) Microscopic appearance of the gluteal tumor. (×175). (B) Shows ossified and unossified portions of the tumor. (×225)

over the body and extremities. The tumors were larger and more numerous over the distal end of the left forearm. One of these tumors was very hard in consistency. A roentgenogram showed an area of increased density within the soft tissue mass. This density, which was not connected with the skeleton, was interpreted as being ectopic bone (Fig. 17).

On March 4, 1937, through a long elliptical incision, a large mass of neurofibromatous tissue was excised. The mass contained 15 small, whitish, encapsulated tumors surrounded by fat. A piece of bone, 5x2 cm., was present.



FIG. 16.—Case 7: Roentgenogram showing metastasis in the third lumbar vertebra, with a bridge of bony density extending from the second to the fourth lumbar vertebrae.



FIG. 17.—Case 8: Roentgenogram showing an extraskeletal shadow of bony density and deformed ulna in a case of von Recklinghausen's neurofibromatosis.

Pathologic Examination.—Microscopic: The soft tissue is composed of cells having rounded or oval nuclei and rather indistinct cytoplasmic borders. There is a large amount of intercellular material consisting, largely, of fine wavy bundles. No mitotic figures are present (Fig. 18 A). The bone is mature in appearance and the marrow spaces within it contain both fatty and hematopoietic marrow (Fig. 18 B). *Pathologic Diagnosis:* von Recklinghausen's neurofibromatosis with bone formation in a neurofibroma.

Case 9.—Case of Dr. Evarts Graham: An incidental finding in a routine autopsy was a pararenal, bony, oval tumor about 5 cm. in diameter. This retroperitoneal encapsulated mass, consisting of cancellous bone, had no connection with the kidney or the vertebral column.

Pathologic Examination.—Microscopic: Section shows the central portion of the tumor to be made up of dense trabeculated bone, while the periphery is more spongy in appearance. The marrow is fibrous in most areas though there is a small amount of hematopoietic marrow present. There is evidence of proliferation of the bone at the periphery; however, there seems to be no tendency toward rapid growth (Fig. 19).

A

B

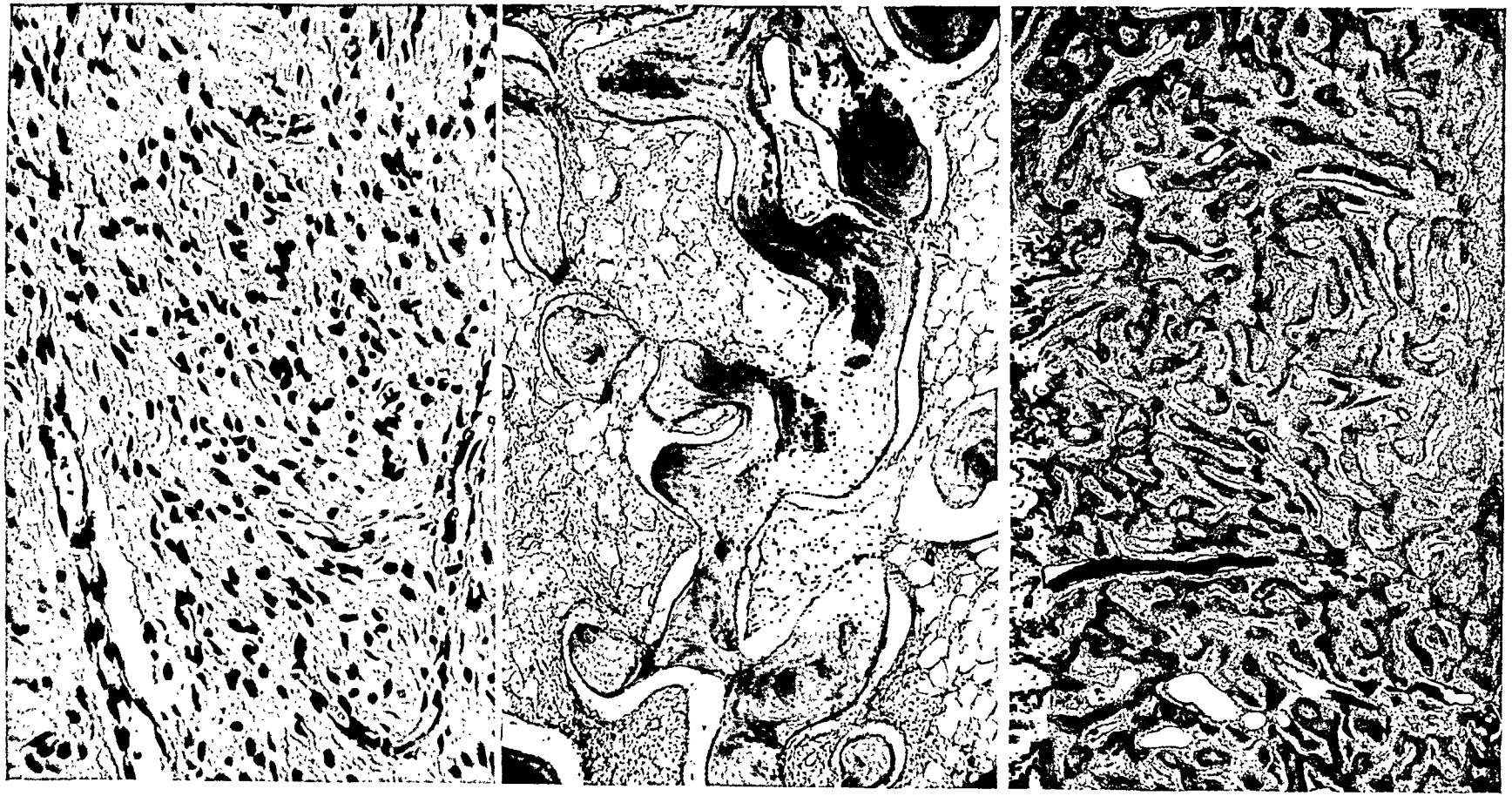


FIG. 18.—Case 8: Microscopic appearance of the tumor. (A) Soft parts. (B) Bone.

FIG. 19.—Case 9: Microscopic appearance of the fibrous osteoma.

This tumor is apparently similar to the case reported by Kretschmer.[21] *Pathologic Diagnosis:* Fibrous osteoma, retroperitoneal.

Case 10.—Case of Dr. Charles Rowan: A young man with a firm tumor was operated upon, December 10, 1911, at Cook County Hospital, Chicago, by Doctor Rowan. Local excision was done. No follow-up of the subsequent course is available.

Pathologic Examination.—Gross: The oval tumor, approximately 10x6 cm. in size, on section consists of firm fibrous tissue and contains scattered areas of bone.

Microscopic.—Section shows the soft portion of the tumor to be composed of fibrous tissue of varying degrees of maturity. A large island of mature bone is present. Its spaces contain both fatty and hematopoietic marrow. At the periphery of one bony spicule is a layer of cartilage which is being invaded by blood vessels and osteoblasts. *Pathologic Diagnosis:* Osteoma of thigh.

SUMMARY AND CONCLUSIONS

(1) Ten cases of extraskeletal ossifying tumors are reported; of these, four are osteogenic sarcomata, one, a fibrosarcoma, with degeneration, calcification and heterotopic bone formation; one, a chondrosarcoma; one, a bursal sarcoma, with ossification in the primary tumor; one, a case of von Recklinghausen's neurofibromatosis, with ossification in a neurofibroma; and two are fibrous osteomata.

(2) This study illustrates the totipotency of neoplastic, mesoblastic tissue.

(3) Myositis ossificans offers the most difficulty in distinguishing heteroplastic from neoplastic bone formation in the soft tissues.

BIBLIOGRAPHY

[1] Alpers, B. J.: Cerebral Osteochondroma of Dural Origin. ANNALS OF SURGERY, 101, 27–37, 1935.

[2] Arnold, S.: Über einen knorpel- und knochenhaltigen Tumor der Brustdrüse. Virchows Arch. f. Path. u. Phys., 148, 449, 1897.

[3] Bianchi, L.: Su alcune forme rare di tumoriumani adenocarcinoma delle ghiandole sudorifere. Osteosarcoma della veschichetta viliare. Boll. d. Soc. Med.-Chir., Pavia, 47, 811–826, 1933.

[4] Broders, A. C., and Pemberton, J. deJ.: Primary Osteogenic Sarcoma of the Thyroid Gland. Surg., Gynec., and Obstet., 58, 100–102, 1934.

[5] Brunschwig, A., and Roome, N. W.: Personal communication.

[6] Budd, J. W., and Breslin, F. J.: Carcino-osteogenic Sarcoma. Am. Jour. Cancer, 31, 207–211, 1937.

[7] Busser, F.: Sarcoma Osteochondroblastique Developpe aux Depens d'un Adenofibrome du Sein. Ann. d. Anat. path., 6, 1247–1251, 1929.

[8] Butler, F. E., and Woolley, I. M.: Osteogenic Sarcoma Arising from a Calcified Hematoma. Radiology, 26, 236–237, 1936.

[9] Caën, E.: Chondroosteosarkom der weiblichen Brustdrüse. Dtsch. Ztschr. f. Chir., 15, 247, 1881.

[10] Chavannaz, M. M., and Pierre-Nadal: Tumeur mixte maligne du corps thyroide. Jour. de med. de Bordeaux, 15, 817–820, 1910.

[11] Dunning, W. F., Curtis, M. R., and Bullock, F. C.: The Respective Rôles of Heredity and Somatic Mutation in the Origin of Malignancy. Am. Jour. Cancer, 28, 707, 1936.

[12] Ferrero: Osteoblastomas. Arch. Ital. di Chir., 12, 236–243, 1925.

[13] Foerster: Über die Geschwülste der Schilddrüse. Würzburger med. Ztschr., 1, 24–36, 1860.

[14] Funkestein, O.: Über Osteochondrosarkome der Thyroidea. Arch. f. Path. u. Phys., 171, 34–79, 1903.

[15] Gomori, G.: Three Uncommon Tumors. Am. Jour. Surg., 33, 150–156, 1933.
[16] Gruber, G. B.: Zur Kritik der Callusbildung, Muskel und Narbenverknöcherung. Virchows Arch. f. Path. Anat., 233, 401–424, 1921.
[17] Haining, R. B., and Poole, P. E.: Osteoblastoma of the Kidney Histologically Identical with Osteogenic Sarcoma. Arch. Path., 21, 44–54, 1936.
[18] Jacobson, S. A.: Two Tumors of Soft Tissue Resembling Tumors of Bone. Am. Jour. Cancer, 25, 763–767, 1935.
[19] Jaidka, K. C.: Ossifying Sarcoma of Vastus Externus. Brit. Med. Jour., 2, 379–380, 1919.
[20] Kreibig, W.: Zur Kenntnis seltener Geschwulstformen der weiblichen Brustdrüse. Virchows Arch. f. Path. Anat. u. Phys., 256, 649, 1925.
[21] Kretschmer, H. L.: Retroperitoneal Pararenal Osteoma. Surg., Gynec., and Obstet., 67, 108–113, 1938.
[22] Kubo, M.: Beitrag zum Studium der primären Mesenterialgeschwülste. Mitt a. d. med. akad. z. Kioto, 11, 302–303, 1934.
[23] Kurosu, S.: Über eine bindegewebige Mischgeschwulst der weiblichen Brustdrüse. Ztschr. f. Krebsforsch., 26, 99–112, 1928.
[24] Magnien and Perrot, M.: Un Cas d'Osteome de la Langue. Ann. d. Anat. Path., 10, 331–334, 1933.
[25] Mallory, T. B.: A Group of Metaplastic and Neoplastic Bone and Cartilage Containing Tumors of Soft Parts. Am. Jour. Path., 9, 965, 1933.
[26] Pick, F.: Zur Kenntniss der Malignen Tumoren der Schilddrüse insbesondere des Sarcoma Ossificans. Ztschr. f. Heilk., 13, 71–85, 1892.
[27] Rhoads, C., and Blumgart, H.: Two Osteoblastomas Not Connected with Bone, Histologically Identical with Osteogenic Sarcoma and Clinically Benign. Am. Jour. Path., 4, 363–370, 1928.
[28] Roffo, A. H., and Meabe, O.: Osteoma eburnea de la mamma del hombre. Bol. Inst. de med. exper. para el estud y trat. del Cancer, 10, 280–286, 1933.
[29] Sailer, S.: Am. Jour. Cancer, 31, 201, 1937.
[30] Sarter, S.: Sarcoma of Breast. Am. Jour. Cancer, 31, No. 2, 201, 1937.
[31] Sehrt, E.: Beiträge zur Pathologie der Milchdrüse. 1. Das Osteochondrosarkom der Mamma. Beitr. z. klin. Chir., 55, 574, 1907.
[32] Solaro, G.: Clin. Chir., 21, 1101–1116, 1913.
[33] Sperling, S. J., and Alpers, B. J.: Lipoma and Osteolipoma of the Brain. Jour. Nerv. and Ment. Dis., 83, 13–21, 1936.
[34] Stilling, H.: Über Osteoidsarkome der weiblichen Brustdrüse. Dtsch. Ztschr. f. chir., 15, 247, 1881.
[35] von Hacker: Über das Vorkommen von Knorpel und Knochen in einer Geschwulst der weiblichen Brustdrüse. Arch. f. klin. Chir., 27, 614, 1882.
[36] Williams, E. R.: A Case of Osteogenic Sarcoma with No Apparent Bone Involvement. Brit. Jour. Radiol., 7, 45–46, 1934.

THE TREATMENT OF STAPHYLOCOCCAL CAVERNOUS SINUS THROMBOPHLEBITIS WITH HEPARIN AND CHEMOTHERAPY

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BACTERIEMIC STAPHYLOCOCCAL CAVERNOUS SINUS THROMBOPHLEBITIS of the anterior or ophthalmic type has been so uniformly fatal that it seems proper to record the survival of two consecutive cases treated with a combination of heparin and chemotherapy. These cases are summarized as follows:

CASE REPORTS

Case 1.—M. G. H. No. 243620: Female, age 31, high school teacher, entered the hospital April 5, 1940, with a nasal furuncle of five days' duration. She had received sulfanilamide at home for three days but the development of signs and symptoms of cavernous sinus thrombophlebitis prompted her physician to refer her to the hospital.

The physical findings on entry are summarized in Table I and the clinical course is shown in Chart 1. Figures 1 and 2 show the patient's appearance on entry and nine weeks later. The clinical course is described further in the following notes:

First hospital day: Heparin and sulfapyridine started.

Fourth hospital day: Sulfathiazol substituted for sulfapyridine.

Eleventh hospital day: Pulmonary infarct.

Seventeenth hospital day: Heparin stopped after a total dosage of 225,000 units.

Twentieth hospital day: Sulfathiazol stopped.

Thirty-fourth hospital day: Clinical signs of meningitis confirmed by lumbar puncture. Sulfapyridine started.

Forty-ninth hospital day: Meningitis still present. Sulfathiazol substituted for sulfapyridine.

Fifty-seventh hospital day: Afebrile and symptomatically improved.

Seventy-seventh hospital day: Discharged home; taking sulfathiazol.

At the time of discharge there was a partial III nerve and complete VI nerve paralysis on the right. Chemotherapy was continued for a total period of four months at which time the spinal fluid protein had returned to normal. The only apparent residuals of the illness are a slight ptosis of the eyelid and high voltage fast brain waves in the electroencephalogram.

Case 2.—M. G. H. No. 80045: Male, age 41, engineer, entered the hospital May 14, 1940, with the diagnosis of acute frontal sinusitis of one week's duration. Physical examination revealed a nasal furuncle and the diagnosis of acute sinusitis was not supported. The clinical course of this patient is summarized in Chart 2 and below:

First hospital day: Sulfapyridine started.

Fourth hospital day: Clinical signs as shown in Table I and Figure 3. Heparin started.

Fifth hospital day: Pulmonary infarct.

Eleventh hospital day: Sulfathiazol substituted for sulfapyridine.

Nineteenth hospital day: Heparin stopped after a total dosage of 580,000 units.

Twenty-eighth hospital day: Appearance as shown in Figure 4 and clinical findings as shown in Table I.

Submitted for publication August 5, 1940.



FIG 1.—Case 1. Showing patient's appearance at time of admission.



FIG. 2.—Case 1: Showing patient's appearance nine weeks later.

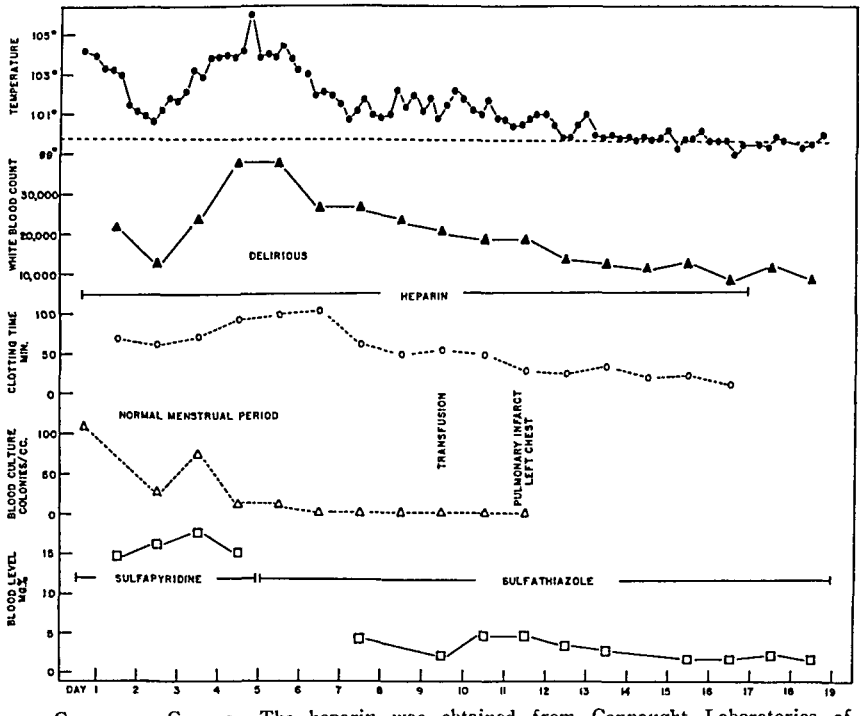


CHART 1.—Case 1: The heparin was obtained from Connaught Laboratories of Toronto 20,000 units of heparin were added to 1,500 cc. of isotonic saline or glucose solution and administered by constant intravenous drip at a rate sufficient to maintain the clotting time of the blood at about 90 minutes as determined by the five-tube method.

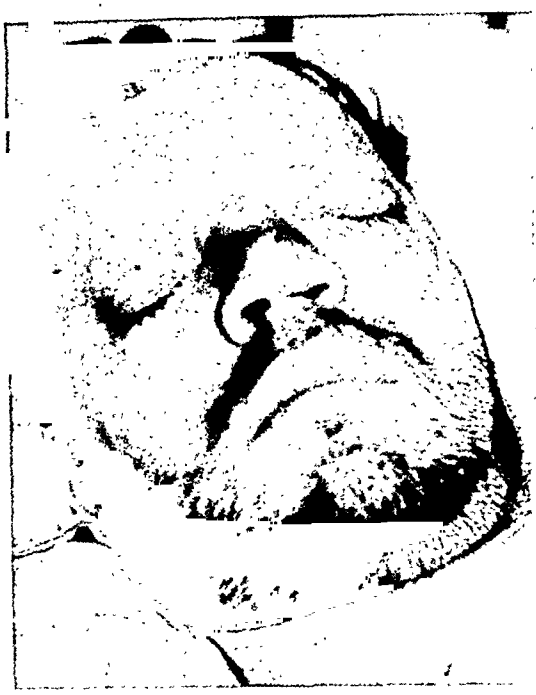


FIG. 3.—Case 2: Showing patient's appearance at time of admission.



FIG. 4.—Case 2: Showing patient's appearance four weeks later.

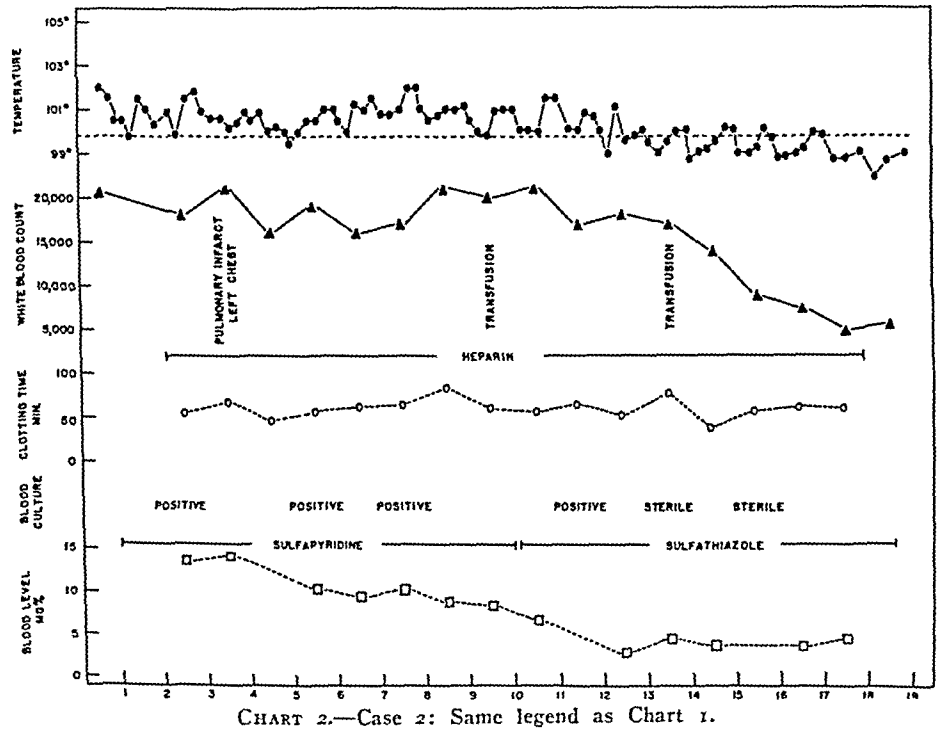


CHART 2.—Case 2: Same legend as Chart 1.

TABLE I

SUMMARY OF CLINICAL FINDINGS

Findings:	Case 1 On Entry	Case 1 After Four Weeks	Case 2 On Entry	Case 2 After Four Weeks
1. Edema:				
Eyelid	+	0	+	0
Bridge of nose	+	0	+	0
2. Exophthalmos	+	+	+	+
3. Retinal hemorrhages	+	0	0	0
4. Palpable frontal veins	+	0	+	0
5. Diplopia	+	+	+	+
6. Cranial nerve palsies				
III oculomotor	+	0	+	0
ptosis	+	+	+	0
IV	+	0	0	0
V 1st div.	+	0	+	+
3rd div. (motor)	+	0	0	0
VI	+	+	+	0
VII (peripheral)	+	0	0	0
VIII	0	0	0	0
7. Evidence of meningitis	+	+	0	0
8. Staphylococcus blood cultures	+	0	+	0
9. Spinal fluid cultures	0	+	0	0

Sulfathiazol was given for three months, at which time the spinal fluid protein was normal. The patient still has a residual hypesthesia of the left frontal region.

DISCUSSION.—The coincident use of chemotherapy and heparin has led to the survival of two consecutive patients with bacteriemic staphylococcal cavernous sinus thrombophlebitis of the ophthalmic type. These two patients ran almost parallel courses in that:

(1) Both developed pulmonary infarcts while receiving heparin. These infarcts healed uneventfully.

(2) Bacteriemia persisted for several days (eight days and six days, respectively); and ten days of treatment was necessary before clinical improvement was definitely reassuring as to the final outcome.

(3) Both patients developed palpable thrombosis of the frontal veins.

(4) Intracranial infection persisted for many weeks after the external evidence of infection had subsided. This was controlled by chemotherapy alone.

(5) Cranial nerve paralyses, demonstrable at the height of the disease, cleared remarkably well during convalescence.

Sulfapyridine was chosen as the drug with which to start treatment because it was known to diffuse into the spinal fluid more effectively than sulfathiazol. During the first few days of treatment Case 1 developed an increase in temperature and disorientation which suggested drug toxemia. Sulfathiazol was substituted for sulfapyridine with continued clinical improvement. Apparent recovery and omission of chemotherapy in Case 1 was followed by the development of a chronic staphylococcal meningitis which did not respond to sulfapyridine but which did respond to sulfathiazol. Full sulfathiazol dosage sufficient to maintain a blood level of 5 mg. per cent was necessary to control this meningitis. In Case 2 it was felt that prolonged treatment with sulfathiazol would be necessary to control this late chronic meningitis,

and it was again determined that the maintenance blood level had to be about 5 mg. per cent to control the infection. Sulfathiazol in adequate dosage seems to be the drug of choice for the treatment of this type of infection.

The use of heparin is quite naturally suggested by the pathology of cavernous sinus thrombophlebitis but there is another important justification of its use. There is reason to believe that staphylococcal bacteriemia usually arises from foci of septic thrombophlebitis in and around areas of suppuration. Such a conception indicates that the attack upon any staphylococcal bacteriemia should attempt to prevent the extension of septic thrombi as well as to destroy the bacteria. The combination of chemotherapy and heparin in these two cases has given better results than has been observed with chemotherapy alone.

CONCLUSIONS

(1) Two consecutive cases of bacteriemic staphylococcal cavernous sinus thrombophlebitis of the anterior type have been successfully treated by a combination of chemotherapy and heparin.

(2) Sulfathiazol, given in dosages sufficient to maintain a blood level of 5 mg. per cent and continued for a long period after the heparin has been discontinued, seems to be the chemotherapeutic agent of choice.

INTRANASAL GRANULOMA OF THE SPOROTHRIX TYPE PRODUCING MARKED NASAL DEFORMITY

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INTRANASAL lesions of the type illustrated by the following case report are rare. This lesion had caused marked nasal deformity before biopsies were obtained which revealed histopathologic features resembling those of sporotrichosis.*

Case Report.—A female, age 31, an artist who had worked in pottery and painting in New York, Kentucky and Illinois, gave a history of nasal bleeding and discharge for three years when first seen by one of us in 1937. She had been relatively well before 1934. By 1935 a thickening had developed in the midportion of the nose, with a depression near the bony-cartilaginous juncture. The local symptoms persisted and deformity progressed despite much treatment. Numerous laboratory studies failed to demonstrate the cause. In April 1936, the first biopsy from the nasal mucosa was described as follows: "Sections show minute bits of stratified squamous epithelium, mucous membrane, portions of blood clot and small portions of connective tissue. These latter are richly infiltrated by polynuclear leukocytes and lymphocytes. . . . In some portions of the connective tissue there are multinucleated giant cells, but one does not recognize any well-defined tubercles. Plasma cells are fairly numerous . . . (Fig. 1). *Pathologic Diagnosis:* Chronic purulent inflammation, possibly on the basis of an underlying granuloma."

In July 1936, roentgenograms of the sinuses, previously clear, showed "edema and absorption of both ethmoids. Both antra and sphenoids involved. The nose shows a saddle-nose deformity below the nasal bones." Roentgenograms of the lungs were normal.

The nasal deformity was marked when we first saw the patient in 1937 (Fig. 2). The coincident contracture had reduced the right nasal passage to one-third and the left to less than one-third of the normal size, preventing good visualization of the intranasal lesion. However, polypoid tissue, crusts and sticky sanious secretions could be seen, especially marked on the left side. The gums were red-rimmed but not swollen, and granulation tissue-filled pockets lay between some of the teeth. The rest of the physical examination was normal.

A biopsy of the gums disclosed chronic inflammation with many plasma cells and neutrophiles, small abscesses and a few small multinucleated cells. Wassermann and Kahn tests were negative, both before and after the injection of arsenicals. The spinal fluid was normal as were blood counts and urinalyses. A roentgenogram demonstrated the deformity of the nose but no disease of the nasal bones (Fig. 3). Roentgenograms of the thorax and sinuses were interpreted as normal. A large number of tests for allergy were negative. Smears and cultures of nasal secretions revealed staphylococci and streptococci but no acid-fast organisms. Dark-field examinations failed to show spirochetes. Two species of fungi, grown on Sabouraud's medium from nasal secretions, were pronounced nonpathogenic.† Neither culture produced lesions when injected into

Submitted for publication August 15, 1939.

* We are indebted to Dr. C. J. Imperatori, of New York City, Dr. Joseph E. Schaefer, of Chicago, Ill., and Dr. Gordon New, of Rochester, Minn., for these biopsies.

† By Dr. Rhoda Benham of Columbia University.

small laboratory animals.* The patient's serum agglutinated spores of a culture of *Sporotrichum schencki* in dilutions up to 1:320, while a control serum agglutinated the same spore suspension only in dilutions of 1:20 and 1:40.* Cultural studies and animal inoculations were again negative in 1939.† Throughout the period of study, the lesions



FIG. 1.—First biopsy, April 1936: Section stained with H. and E. (×125). Fragment densely infiltrated with plasma cells and lymphocytes, with a few neutrophiles and, on the left, giant cells.

proved resistant to various types of local and general therapy and general symptoms were negligible save during treatment with iodides to which the patient was hypersensitive. The two biopsies secured in October, 1937 and February, 1939 are described below, and illustrated by Figures 4, 5, 6 and 7.



FIG. 2.



FIG. 3.

FIG. 2.—(A). Showing the nasal profile of the patient prior to 1934–1935. (B). Showing the nasal profile of the patient in the summer of 1937.
FIG. 3.—A profile roentgenogram of the nose in the summer of 1937.

* According to Dr. Bertha Kaplan Spector of the University of Chicago.
† At the Mayo Clinic.

Histopathology.—Only the original H. and E. sections of the first biopsy were available, but sections of the others were stained by methods suitable for demonstrating bacteria and other organisms. All three biopsies were similar. The fragments were obviously parts of a polypoid granuloma, covered by stratified squamous epithelium and focally ulcerated. A thin exudate lay over the erosions and a few neutrophiles invaded

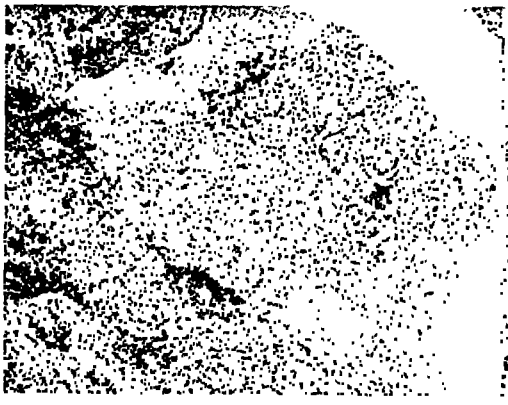


FIG. 4.—Second biopsy, October 1937: Section stained with H. and E. (×125). Polypoid, ulcerated mass densely infiltrated with plasma cells and other leukocytes; giant cells near right border.

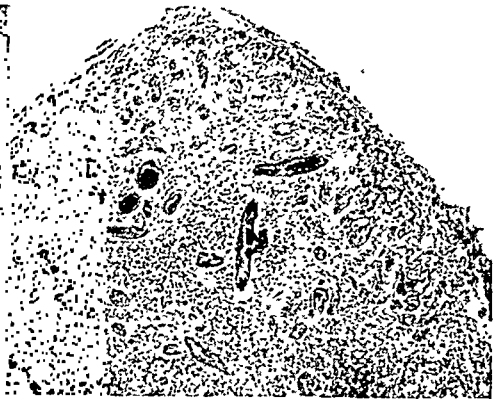


FIG. 5.—Second biopsy: Section stained by Unna-Pappenheim method (×125). Loose vascular granulation tissue at surface of polypus, with many plasma cells, a few neutrophiles and several giant cells in deeper portion.

the intact epithelium. The superficial zones of the fragments were edematous and very vascular, infiltrated by plasma cells and lymphocytes. They had focal accumulations of neutrophiles and macrophages many of which contained nuclear débris. A few multinucleated giant cells were present. The denser deep portions had many plasma cells,



FIG. 6.—Second biopsy: Section stained by Unna-Pappenheim method (×125). Dense granulomatous tissue from deep region with tuberculoid foci and many giant, epithelioid, and plasma cells.

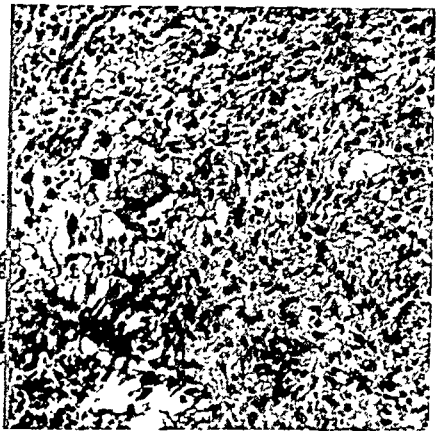


FIG. 7.—Third biopsy, February 1939: Section stained with H. and E. (×275). The "syphiloid, tuberculoid and ecthymatoid"[4] features illustrated by top zone, with many plasma cells and lymphocytes; middle zone, with multinucleated and epithelioid cells; dense lower zone, with focus of neutrophiles bordered by epithelioid cells.

epithelioid and giant cells, and some eosinophiles and mast cells scattered through a fibrous stroma. Neutrophiles were scarce save in small foci which combined the features of miliary tubercles and small abscesses. In these lesions neutrophiles were mixed with seminecrotic tissue in their centers while epithelioid cells formed their borders. While these foci were tuberculoid there were no typical tubercles. The numerous giant cells were scattered irregularly and while some were of the Langhans' type others had grouped nuclei and the bizarre forms of foreign-body giant cells.

Careful search revealed a few gram-positive cocci and rods and gram-negative rods, all on or near the eroded surfaces. Deeper, and usually in macrophages, were a few coarse round or oval gram-positive bodies, the latter 4–5 μ long and 2–3 μ broad. These were blue with H. and E. and Giemsa stains and red with the Unna-Pappenheim stain. While these bodies stained as do gram-positive bacteria or fungi they were coarser than most bacteria. However, they were not positively identifiable as fungus spores.

Discussion of Histopathologic and Clinical Features.—The almost identical granulomatous features of all three biopsies would seem to point to the prolonged action of a single causative agent. Foreign bodies, chemicals, allergens and living organisms all may incite inflammation of a granulomatous character. In consideration of the etiology in this case the action of a foreign body could be excluded. Although this patient was hypersensitive to iodine, this drug probably did not play a part in etiology. The disease was established before iodides were given, and the histopathology was unlike that attributed to iodine.[7] Other chemical and allergic factors could be excluded on the basis of the various tests made. On the whole the most probable cause would seem to be an infection. In view of the slow progression of the nasal lesion and the mild general symptoms, an infectious agent of low pathogenicity would be suspected.

The histopathology was unlike that of the common chronic pyogenic infections, and of the less common granulomata attributed to pyogenic organisms, such as botryomycosis and granuloma pyogenicum. From the clinical, laboratory and morphologic data both syphilis and tuberculosis could be excluded. Rarer granulomata also may affect the upper respiratory tract but most of them have distinctive clinical and morphologic features or readily demonstrable causative agents. Of these, rhinoscleroma, rhinosporidiosis, coccidioidal granuloma, leprosy, leishmaniasis, granuloma venereum and glanders could almost certainly be excluded. Despite certain similarities to granulomata caused by yeasts and filamentous fungi, organisms of the types responsible for the more common mycotic infections such as blastomycosis and actinomycosis could not be found.

One granuloma which may affect the upper respiratory passages[1, 4, 5, 6, 9, 12] could not be dismissed so readily from consideration of the possible etiology. While sporotrichosis is commonly a disease of the skin and lymphatic structures it sometimes affects deeper tissues and organs. Cases have been described, with or without lesions of the skin, and with involvement of muscles, bones, joints, and various viscera and mucous membranes.[2, 4, 8, 10, 13, 14, 15] Such lesions are notoriously resistant to therapy with iodides, as were the lesions in the case presented. Illustrations and descriptions of mucosal sporotrichosis, especially the classic descriptions of de Beurmann and Gougerot,[4] are very like those in this case. These authors stressed the mixture of syphiloid, tuberculoid and ecthymatoid features in the inflammatory reactions and the difficulty of demonstrating spores. Others[3, 11] have stressed the same difficulty with all save superficial sporotrichotic abscesses.

Obviously, a positive diagnosis of sporotrichosis cannot be made in this

case. Morphologic evidence alone cannot be more than suggestive. The failure to obtain proof by culture on suitable medium or by inoculating animals must be cited. It should be noted, however, that it was extremely difficult to obtain suitable inoculum from the deep-seated lesions through the narrowed nasal passages. Too, it may be argued that the agglutination test may not have been specific. However, the titer of 1:320 was notably higher than those reported with control sera, or obtained in cross-agglutination tests with sera from patients with other mycotic diseases.

SUMMARY

A case is reported of a patient with a marked nasal deformity due to a granuloma of unknown etiology.

Most of the common and rare granulomata known to affect the mucous membranes of the upper respiratory passages could be excluded from consideration of the possible etiology.

The histopathology of three biopsies from the nasal mucosa of this patient, secured at widely separated intervals, was more like that of sporotrichosis than of other known granulomata.

While proof of the etiology is lacking, the clinical and morphologic features warrant characterizing this as a sporotrichosis-like granuloma.

BIBLIOGRAPHY

[1] Albright, G. C.: Sporotrichosis of Nose. Laryngoscope, 33, 875–881, 1923.

[2] Beitzke, H.: Seltene Mykosen d. Knochen u. Gelenke. Hdb. d. Spz. Path. Anat., pp. 612–623, Berlin, Springer, 1934.

[3] Benham, Rhoda W.: Gay's Agents of Disease and Host Resistance. pp. 1130–1133, Springfield, Chas. C. Thomas, 1935.

[4] de Beurmann and Gougerot: Les Sporotrichoses. Paris, Felix Alcan, 1912.

[5] Costa, S.: Chancre Syphiloide de la Muqueuse Nasale, Lymphangite et Adenite, Provoqué par le Sporotrichum Beurmanni. C. R. des S. de la Soc. Biol., 71, 35, 1911.

[6] Danlos and Flandin: Sporotrichose de la Portion Cartilagineuse de la Cloison des fosses nasales. Bull. de la Soc. Franc. de Derm. et de Syph., 20, 251–253, 1909.

[7] Eller, J. J., and Fox, E. C.: Fatal Iododerma. Arch. Dermat. and Syph., 24, 745–757, 1931.

[8] Fazakas, A.: Sporotrichose des Untern Tränen Kanälchens. Klin. Monatsbl. f. Augenheilk., 96, 227–230, 1936.

[9] Grimes and Lecoanet: Au Sujet d'un Cas de Sporotrichose du Larynx. Bull. de la Soc. de Path. exot., 27, 901–903, 1934.

[10] Hyslop, G. H., Neal, J. B., Kraus, W. M., and Hillman, O.: Case of Sporotrichosis Meningitis. Am. Jour. Med. Sci., 172, 726–740, 1926.

[11] Lawless, T. K.: Pathologie der Sporotrichose. Dermat. Ztschr., 40, 257–288, 1923–1924.

[12] Letulle, M., and Debré, R.: Sporotrichose de la Peau, de la Bouche, du Larynx et de la Trachée. Bull. et Mem. de la Soc. Méd. des Hôp. de Paris, 25, 379–396, 1908.

[13] Milhit, J., Martin, A., and Delon, J.: Un Cas de Sporotrichose Renale. Bull. de la Soc. de Pediat. de Paris, 33, 592–597, 1935.

[14] Sartory, A., Sartory, R., Meyer, J., and Meyer, M.: Deux Cas d'Osteitis. Ann. Inst. Pasteur, 52, 424–443, 1934.

[15] Wolbach, S. B., Sisson, W. R., and Meier, F. C.: A New Pathogenic Sporotrichum Found in a Case of Acute Arthritis of the Knee Following Injury. Jour. Med. Res., 36, 337–355, 1917.

VARICOCELE AND ITS TREATMENT

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IN A TEXT-BOOK on the Practice of Surgery by Samuel Cooper,[1] in 1828, the term "varicocele" implied nothing more than an unnatural dilatation of the blood vessels of the scrotum, and was considered a disease of no importance. The term "circocele" was applied to the condition that is to-day commonly known as varicocele. It was described as a varicose distention and enlargement of the spermatic veins. Cooper also stated that it frequently occasioned great uneasiness and sometimes a wasting of the testicle, and was usually limited to that part of the spermatic cord below the abdominal ring. This fulfills the description in text-books of to-day, except that one may add there is a lengthening of the veins, that it occurs most frequently in young, unmarried adults, and is on the left side in 90 per cent of the cases.

Anatomy.—The spermatic veins on each side issue from the testis and epididymis and form the pampiniform plexus. This plexus is one of the constituents of the spermatic cord and consists of ten or twelve veins, most of which lie anterior to the vas deferens. For practical considerations, the plexus can be arranged in three groups: (1) The most anterior, which has in its midst the spermatic artery; (2) the middle, which has the vas deferens with its accompanying lymphatics and nerves; and (3) the posterior, composed of those veins which pass upward from the tail of the epididymis. The anterior group is the one first affected, or, if the dilatation affects all the veins, it is the group most extensively involved. The pampiniform plexus passes upward, unites within a short distance of the internal inguinal ring to form the spermatic veins, and ascends with each corresponding spermatic artery. Shortly before their termination, the veins unite to form one stem, which on the right side opens at an acute angle into the inferior vena cava below the renal vein, while on the left side it opens almost at a right angle into the lower border of the renal vein. According to Piersol,[3] the spermatic veins proper possess no valves, but there is usually a pair at the entrance of the right vein into the vena cava. In the stems of the pampiniform plexus, however, valves are usually found, but they are very frequently insufficient. An operation has been described by W. Turner Warwick[9] in which he excises only the involved stems and leaves a channel containing the competent valves.

Etiology and Classification.—Two types of varicocele are recognized: (a) Spontaneous, idiopathic, or primary; and (b) secondary or symptomatic. Secondary varicocele results from spermatic vein obstruction by intra-abdominal tumors, most often of the kidney, but occasionally large carcinomata

Submitted for publication April 26, 1939.

of the pelvirectal region. The sudden appearance of a right-sided varicocele is suggestive of an abdominal tumor and, according to Bates,[4] varicocele is a symptom in 30 per cent of kidney tumors. Varicocele of obstructive origin can be diagnosed by placing the patient in the prone position, at which time one can note that the veins do not readily empty themselves, as in the primary type. Removal of the obstructing tumor mass constitutes the treatment.

Primary varicocele is the type commonly seen. Usually the etiology is obscure or unknown. Age apparently is a factor, because it occurs in young individuals during the period of greatest sexual potentiality; nearly all are unmarried and have opportunities for sexual relief inadequate to their desires, which serves to perpetuate a constant genital congestion. Abuse by sexual excesses or masturbation may also result in this condition. Although most young adult males are subjected to sexual influences conducive to chronic pelvic congestion, only about one in ten develops varicocele. For years, the left-sided preponderance has been explained on an anatomic basis; namely, that (1) the left vein opens at an acute angle into the vena cava; (2) the left vein is destitute of valves at its opening into the renal, while the right one usually possesses a pair at its orifice; (3) the left vein in its course up the abdominal wall lies beneath the sigmoid colon, while the right has only coils of small intestine with their more fluid contents; (4) the left testicle hangs lower and the left spermatic vein is longer. Vascular dysfunction is more common in old men in whom varicocele is rarely encountered but in whom varicosities and hemorrhoids are frequent. The fact that the left spermatic vein passes under the sigmoid, which may obstruct the vessel, has been advanced as a cause of varicocele, but chronic constipation with an overloaded sigmoid is characteristically a disease of advancing years. The actual cause is unknown, but chronic passive genital congestion is probably the underlying factor, as is demonstrated by the disappearance of most varicoceles and the symptomatic cure of many with the assumption of normal sex relationship of marriage.

Symptoms.—Occasionally varicocele may follow violent strain and be accompanied by severe local pains. Usually the onset is gradual. Many patients have varicoceles of considerable size without symptoms; occasionally they complain of the inconvenience of the relaxed scrotum and low hanging testicle, especially in warm climates. Often the symptoms are those of sexual neurasthenia, along with a variety of generalized aches and pains out of all proportion to the objective findings. Of the uncomfortable stimuli produced by varicocele, the most frequent is a dragging sensation in the testicle referred to the groin, lower abdominal quadrant, or lumbar region; a dull aching pain in the testicle may be constant, aggravated on exercise.

Diagnosis.—On examination, one notes a relaxed scrotum and a low hanging left testicle with the tortuous veins often visible. On palpation there is the typical feeling likened to a bag of earthworms. These findings can rarely be confused with any other condition. A large hydrocele or

hernia may obscure the varicocele. The testicle may show some atrophy. Perhaps the only condition it may be confused with is omental hernia. A sure method of distinguishing the two complaints is as follows: Place the patient in a horizontal position and empty the swelling by pressure on the scrotum; then place the finger firmly upon the upper part of the abdominal ring and have the patient rise; if it is a hernia, the mass cannot reappear as long as the pressure is continued at the ring, but if it is a varicocele, the swelling returns with increased size because the return of blood into the abdomen is prevented by the pressure.

Treatment.—Samuel Cooper,[1] in his treatise on the Practice of Surgery, states that a radical cure can seldom be effected. He advocates supporting the testicle with a suspensory bandage and if necessary the use of cold and alum lotions; also, that the blood be repeatedly taken away by means of leeches. From his observations, and the reports from very good authors, pointing out the severe complications which may and do result from varicocelectomy, we are apparently considering the operation too lightly, as too many such operations are being performed. According to Campbell,[10] Douglas, in a careful follow-up in 106 of 305 cases operated upon for enlistment in the Army, found 48 per cent normal after a postoperative intermission of many months, 39 per cent had hydrocele, and four had atrophy. This is not a very cheerful report when one considers surgical treatment.

Therapeutically, three types of varicocele are recognized: The first is asymptomatic anatomic varicocele, which may be either large or small. In this type of case, operation is not indicated; however, we do operate upon some of these cases when sent into the hospital by ship's physicians who refuse to pass the individuals for duty on boats. In the second type of case the patient presents himself with a scrotal enlargement and a feeling of weight or a dragging sensation, either in the testicle or referred to the cord, groin or loin. This is the type of case in which operation is definitely indicated; however, the number of such cases presenting themselves each year, with symptoms severe enough to warrant operation, is small, perhaps not over five or six. In the third type, unfortunately, fall a large number of the cases. These are the individuals who have a small varicocele with a variety of symptoms and anxiety regarding the integrity of their sexual apparatus. This type of case requires the utmost consideration and is entitled to some patience on our part and an explanation of the mechanism of varicocele, with assurance that the condition is not a serious one. Even then, we are forced to operate upon some of them because they will not or cannot help themselves.

Injection treatment is advocated by some, who state that it is practically 100 per cent successful and that it avoids the two ever present possibilities which may follow operation, namely, atrophy of the testicle and secondary hydrocele. Different methods are described, but each points out that perivascular infiltration will not effect a cure and secondary injections are difficult. Although injection may achieve the same effect as the ordinary surgical

FIG. 1.
Before operation.
Showing incision and low scrotum.

FIG. 2.
Showing site of fascia strip

FIG. 3.
Showing start of fascia strip

FIG. 4.
Fascial strip sutured to tunica vaginalis with silk

Annals of Surgery
January, 1941

FIG. 5.
Closure of aponeurosis of external oblique

FIG. 6.
After operation. Showing healed incision and elevated scrotum.

PLATE I.—Showing the various steps of the operative procedure employed in the suggested modification of Londres' operation for varicocele (Hospital News, 4, No. 16, 1937).

operation, the amount of the plexus obliterated is not so easily controlled by injection as by operation. I think that we have all seen patients who are better satisfied with the final results following operation than we are ourselves. In this regard, according to Warwick,[9] Carver and Nitch reviewed 100 cases and found that 20 still suffered pain and four were even worse after the operation; also, in spite of the fact that a hydrocele was present in 23, fibrosis of the testicle in 55, and atrophy in 21, it was found that at least 70 of the patients were comfortable and well satisfied with the operation. Unquestionably, if this represents a satisfactory standard of amelioration in this condition, it may eventually prove that injection treatment may very well serve the purpose. In the absence of this knowledge it is my opinion that, in carefully selected cases, operation is the method of choice.

Operative Procedure.—Numerous procedures have been resorted to in the treatment of varicocele, but the usual operations performed can be placed in two groups: (1) Those designed to act directly on the varicose veins of the pampiniform plexus; and (2) those which seek to promote a simple suspension of the varicose plexus, either by resection of the scrotal sac or by simple suspension of the testis. Until three years ago, the method I employed was anchoring the distal end of the cut anterior pampiniform plexus to the external ring (Vincent's operation), together with resection of the scrotum when atony was marked. The results were satisfactory, but this did not always give permanent suspension of the testis. In January, 1934, Loñdres[8] reported an operative technic for suspension of the testicle which is easy, quick, and apparently harmless and, it appears to me, more than any other procedure offers possibilities for an efficient permanent suspension. The following is a description of the operation: It consists in suspension of the testicle by means of a flap cut from the fascia of the external oblique muscle, which is folded downward (Figs. 2 and 3), its pubic insertion remaining attached and its loose end being fixed to the testicle just below the ischiopubic bone. The opening made in the fascia of the external oblique is sutured after one has assured himself that the external inguinal opening has retained a proper diameter.

The resistance of the strip of fascia, together with the fact that it will not stretch, guarantees the lasting suspension, counteracting the distention due to dependency and relieving the weight on the vas, the common cause of cord pain. We have been using a strip of fascia about one-quarter of an inch wide and two inches long, anchoring the free end to the upper portion of the tunica vaginalis with silk (Fig. 4). In addition to the suspension, we have been removing a section of the anterior pampiniform plexus, if markedly varicosed, due care being given not to injure the spermatic artery and not to interfere with the middle or posterior portion of the cord. In doing this we would rather err by not removing enough veins than too many, as we believe that the return flow of blood from the testicle is important to prevent complications.

The objection that presents itself to this operation is the possible trauma to the testis and tunica which is supposed to be one of the causes of hydrocele formation. During the past six years we have operated upon 44 cases in this manner with very good results and without any ill effects. Over half of these cases have been observed for a period of a year or longer, and it was found that they were completely relieved of symptoms, did not have any hydrocele and the fascia support was holding the testicle in the proper position. It is questionable whether it excites an inflammatory process already present, as Campbell[10] states that the specific gravity of the fluid is that of an inflammatory exudate rather than a transudate resulting from vascular disturbance.

CONCLUSIONS

The etiology of primary varicocele is usually obscure. It occurs in young individuals, rarely in men of advanced years, when vascular dysfunction is more common. Marriage commonly effects a cure. The diagnosis is usually easy and rarely mistaken for any other condition. Varicoceles have been grouped into three types, according to the classification of Campbell,[10] which appeals to me as being a very good method in selecting cases for operation. The common complications of operative treatment are hydrocele and atrophy of the testicle, and in some reports these complications seem to be rather high. Cases for operation should be carefully selected and the operation should not be considered a minor procedure, care being taken in technic and identification of various structures which possibly may be a factor in producing the above complications. If the case is not one for operation, the patient should not just be given a suspensory, which is often unsanitary and ineffectual, but his condition should be explained to him as not being a serious one and one that will not affect him in any way. The operation of choice is one of the suspension type. The patient usually remains in bed for five to seven days, and wears a testicular support for 30 days.

REFERENCES

[1] Cooper, Samuel: Practice of Surgery. 3rd American ed. of 3rd London ed., Ide Simeon, 1828.

[2] DaCosta, J. C.: Modern Surgery. 9th ed., Saunders, 1926.

[3] Piersol, G. A.: Human Anatomy. 5th ed., Lippincott, 1916.

[4] Bates, J.: Symptomatic Varicocele. Jour. Urol., 18, 649–661, December, 1927.

[5] Arce, Jose: Technic of Ivanissevich Operation for Varicocele. Surg., Gynec. and Obstet., 43, 687–689, November, 1926.

[6] Smith, T. O.: Clinical Experience in Injection Treatment of Varicose Veins and Allied Conditions. Canad. M. A. J., 22, 627–635, May, 1930.

[7] Porritt, A. E.: Injection Treatment of Hydrocele, Varicocele, Bursae and Naevi. Proc. Roy. Soc. Med. (Section Surgery), 24, 81–85, May, 1931.

[8] Londres, Jose: Surgical Treatment of Varicocele. ANNALS OF SURGERY, 99, 185–187, January, 1934.

[9] Warwick, W. Turner: Pathology and Treatment of Varicocele. Lancet, 1, 517–519, March, 1931.

[10] Campbell, Meredith F.: Varicocele. Surg., Gynec. and Obstet., 47, 558–565, October, 1928.

INDELIBLE PENCIL INJURIES TO THE HANDS

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INJURIES to the hands and fingers by the points of indelible pencils are fairly infrequent, but the characteristic chain of events which follows them warrants the occasional report of a case and justifies reemphasis of their importance. The severely irritative and destructive properties of aniline dyes, when introduced into the eye by the "lead" of indelible pencils, was recognized many years ago by the ophthalmologists (Gräflin,[21] Kuwahra,[25] Vogt,[38] Dejean,[12] Marshall,[27] and Bride[8]). The eczematous and acneform eruptions, papillary growths and, very rarely, epithelioma of the skin from aniline dyes, are well recognized by the dermatologist (Sachs[35]). Bladder carcinoma in aniline dye workers is a classic example of malignancy due to chemical irritation (Rehn[34a]). Puoz,[34] in a general review of the subject, noted one patient who suffered severe injury from the introduction of an indelible pencil into the urethra, and Ilkoff[22] reported on the effects of indelible lead on the gastrointestinal tract of a patient who was given, as a joke, a beefsteak containing a piece of indelible pencil.

Sigmund Erdheim,[14] in 1914, was the first to report indelible pencil wounds of the hand. Glass,[20] in 1922, first called attention to the general toxic manifestations of indelible injuries. Excellent reviews of indelible pencil injuries have been published by Anglesio,[1] Arce,[2] Bettazzi,[4] Bianco,[5] Bravo and Canedo,[6] Bull,[9] Buzzi, Costa and Derqui,[10] Dalquen,[11] Erdheim,[14] Gierlich,[17] Glass and Krüger,[19] Iselin,[23] Marsiglia,[28] Milch,[31] Perez,[33] Puoz,[34] and to these papers the reader is referred for more extensive discussion.

The "lead" of indelible pencils is made up of inert substance or filler, usually graphite, an inert binding substance, and a dye which gives the color and "indelible" property to the "lead." The dye has been proven to be the toxic agent (Kuwahra,[25] Vogt,[38] Erdheim,[14] Glass and Krüger,[19] and others); the other components behave simply as inert foreign bodies and differ in action in no way from ordinary graphite pencil which may lie buried in the tissues for years (60 years in the case of Glass,[20] 1931).

The dyes used belong to the triphenylmethane, diphenylmethane and diphenylamine groups, the most frequently used being methyl violet of the triphenylmethane group. The toxicity of the dyes is associated with their reaction; they become increasingly toxic with increasing alkalinity, and may be listed in order of increasing toxity as follows: Green, yellow, red, brown, blue, violet, and black. It has been pointed out by Vogt,[38] that the difference

Submitted for publication September 26, 1939.

in toxicity is one of degree only, and that all cause chemical necrosis. It would seem that they produce a disturbance in cellular metabolism due to the chemical affinity of the alkaline dye for nucleic acids in the nuclei of the cells.

When indelible "lead" is introduced into the tissues, the dye at once begins to dissolve, and leads to a necrosis of the adjacent cells. As the highly concentrated dye is carried farther outwards the area of necrosis enlarges and all tissues in its path are involved—the skin and its appendages, connective tissue, fat, muscle, nerves, cartilage and bone. Where blood vessels are subjected to high concentration of the dye, they become totally necrotic and thrombosed; farther away, where the dye is less concentrated, the necrosis may involve only the adventitia, while the media and intima may show round cell infiltration and proliferation. It is possible, as Ettore[15] has suggested, that this thrombosis and associated secondary infection may be factors in producing the extensive necrosis which may involve whole digits or phalanges.

A protective wall of leukocytes is thrown up about the advancing process, but it is pushed back farther and farther until the dye is diluted beyond the point of toxicity, has been altered by local metabolism, or has been carried away by the blood and lymph. Then the process comes to a standstill, the protective wall liquefies, and the necrotic central mass is cast off, leaving an ulcer which heals slowly by granulation. Superficial areas may separate and heal spontaneously in five or six weeks. If the dye has penetrated deeply, months or even years may elapse. Occasionally, a very slight injury may result in tattooing. Sharlit[36] has recorded one instance in which a melanoma developed in such a tattooed area.

The local clinical manifestations of indelible wounds of the hand may be minimal. At the time of the injury there is some pain which persists for an hour or so, and along with this there is edema of the surrounding tissues. If the injury is near a nerve there may be sensory loss over its peripheral distribution. As the dye becomes more widely diffused the reaction becomes more marked, the pain may recur, and may radiate distally or peripherally; but it is remarkable that pain is rarely the presenting symptom. The puncture wound continues for a long period of time to secrete a purple fluid which discolors the dressings.

If the fistulous tract is simply incised and an attempt made to remove the lead, the incision refuses to heal and the process becomes an ulcer with violet base and borders. Occasionally, if the penetration has been quite deep, the puncture wound heals and a tumor-like mass develops which, if incised, leaves a purple ulcer that persists for weeks or months before healing occurs.

General symptoms are not always present, but in about 20 per cent of cases (Puoz) complaint is made of headache, malaise, anorexia, gastro-intestinal upset, and general weakness. Such symptoms do not often come on for several weeks after the injury, may be associated with fever and increased white cell count, and, as in a case reported by Gartenmeister,[16] icterus may develop. Torraca[37] found experimentally that although the kidneys showed the most damage, the liver was also affected by methyl violet; and Glass[19]

found that the lungs, heart, liver, spleen, and kidneys of mice receiving methyl violet, were markedly congested and that the liver showed capillary hemorrhages and leukocytic infiltration. Gierlich,[17] on postmortem examination of a premature infant who had been given indelible lead, found toxic changes in the parenchymastous organs. He showed experimentally that the dye is absorbed as a colorless substance into the blood stream and acts as a protoplasmic poison, producing anemia, cloudy swelling and accumulation of fat globules in the cells. In one experiment an acute yellow atrophy of the liver was produced.

In one of our cases (Case 2) anorexia, weakness, lassitude and a brief postoperative febrile reaction seemed due to toxemia from the dye rather than to a concurrent local infection. This was particularly striking since the toxic symptoms did not develop until seven weeks after the injury, and the anorexia and lassitude persisted for several weeks after the local process had subsided.

The treatment of indelible pencil injuries is complete, immediate excision, care being taken that no tissue stained by dye is left behind. If this can be effected at once, the wound may be safely sutured with assurance of primary healing. The "lead" should never be picked out with forceps, which breaks up the foreign body and scatters bits of the dye throughout the tissues. In the late case, removal of dye-stained tissue is also indicated; but where bones, tendons and other essential structures are involved, complete excision may be impossible. In such instances the wound is left open and allowed to heal by granulation. In other instances complete excision and primary closure may be accomplished even as late as two and one-half months after injury (Case 1). At times (Jerusalem[24]), the necrotizing action may be so severe and extensive that amputation is necessary.

The systemic reaction is due to absorption of the dye or of some of its products. It has been shown that the dye is very slowly excreted by the kidneys. However, the common occurrence of gastro-intestinal symptoms and an occasional instance of icterus would seem to indicate that the liver must also play a rôle in the excretion of the dye. For this reason, it seems logical to administer glucose and prescribe a liberal carbohydrate diet when toxic symptoms occur.

CASE REPORTS

Case 1.—Cook County Hospital, Nos. 1689466, 1690535 and 8873: J. S., male, age nine, injured the dorsum of the right index finger with an indelible pencil, December 3, 1937. He squeezed the wound and made it bleed, but did not remember whether he succeeded in removing the point of the pencil. The following day the finger became swollen and there was discharge of bluish fluid, but there was no pain or tenderness. Four days after the injury the patient was admitted to Cook County Hospital where the wound was simply cleansed and dressed and the patient was instructed to report to the Hand Clinic for dressings, where he reported three days later, December 10, 1937, at which time there was noted a fusiform swelling of the finger and an ulcer about 3 Mm. in diameter (Fig. 1), from which thin, bluish fluid exuded. The finger was cleansed and splinted and the patient advised to apply dry heat at home.

He was readmitted to the hospital, three days later, with a moderately severe infection which subsided quite rapidly under cleanly care and moist heat. Following discharge from the hospital he reported for dressings until February 19, 1938, at which time the sinus had healed, leaving a blackish, discolored area about 1 cm. in diameter. He was again admitted to the hospital and the finger opened, under a general anesthetic. The skin and subcutaneous tissue, over an area of approximately 1 cm. in diameter, were purple and gelatinous, and the extensor tendon over the distal interphalangeal joint was soft and necrotic. All involved tissue was excised, the wound sutured, and the finger splinted in hyperextension. The wound healed by primary intention in about ten days. The splint was left on for five weeks in order to allow firm healing of the extensor tendon defect, and a good functional result was obtained (Fig. 2 A and B).

The microscopic examination of the excised tissues showed, in the skin, a small accumulation of round cells with single foreign body giant cells embedded deep in the reticular layer of the dermis. On section through the tendon there is a dense, firm collagen



FIG. 1.—Case 1: Indelible pencil injury to dorsum of index finger. Before excision.

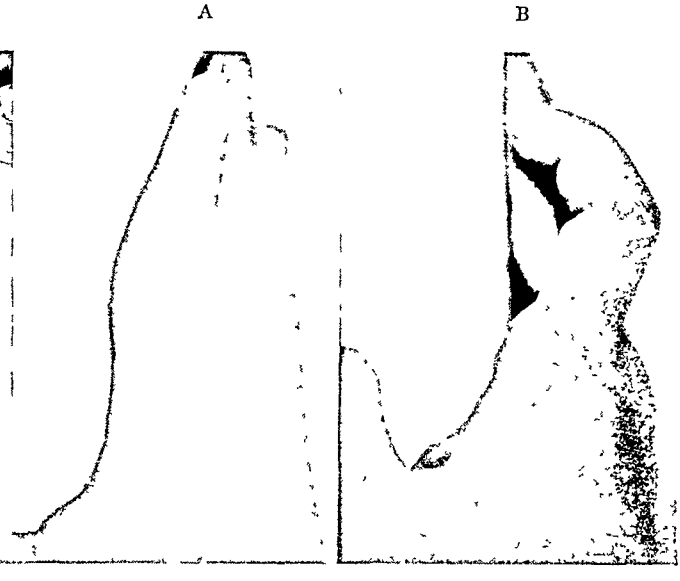


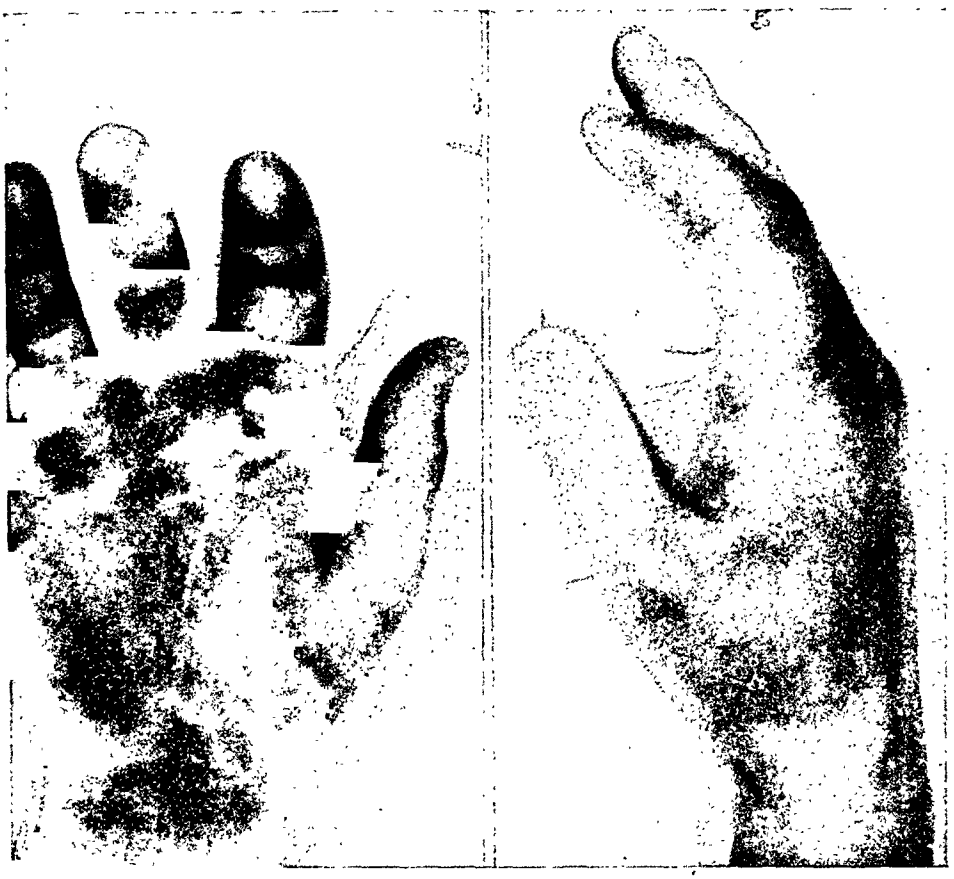
FIG. 2.—Case 1: A and B. Indelible pencil injury to dorsum of index finger. Return of function after excision and suture.

connective tissue in which are found spicules of coal-black pigment. In one area this pigment is surrounded by round cells and single foreign body giant cells" (Alex. B. Ragins, M.D., Pathologist).

Case 2.—Passavant Memorial Hospital, Nos. 41849 and 43322: R. T., male, age 17, was admitted to the hospital, April 27, 1939, with the history of, seven weeks previously, having had the lead of an indelible pencil accidentally driven into the palm of the right hand. He had been taken at once to a physician who extracted the piece of lead and applied moist packs. During the first week after the injury there was considerable swelling about the wound, there was an elevated temperature, local redness, and pain on motion. There was some purplish discharge from the wound. During the second week the symptoms subsided, and by the end of this week the puncture wound had healed. During the ensuing five weeks the swelling receded, pain and tenderness disappeared, and the patient regained complete use of the finger. There remained, however, a small grayish spot where the pencil point had entered. Two days previous to admission to the hospital, and seven weeks after the original injury, the swelling, pain and tenderness recurred, and hot, moist compresses were again applied. The process, however, became steadily worse and he was admitted to the hospital with a temperature of 100.4° F., and

a white cell count of 12,630. Examination showed a tense, uniformly swollen right index finger, held in semiflexion. In the palm over the region of the second metacarpophalangeal joint was a small sinus with grayish borders exuding grayish liquid (Fig. 3 A and B). Pressure over the course of the tendon sheath produced pain, as did both flexion and extension of the finger. There were no enlarged lymph nodes in the epitrochlear or axillary regions and no evidence of a lymphangitis. *Clinical Diagnosis:* Suppurative tenosynovitis secondary to indelible pencil injury. Drainage was immediately established.

Operation.—Under general anesthesia, a transverse incision was made over the proximal culdesac of the tendon sheath, directly through the sinus tract. A second, longitudinal, incision was made along the radial border of the finger. A grayish, purulent exudate was found both in the culdesac of the sheath and in the sinus tract.



A B

FIG. 3.—Case 2: A and B. Indelible pencil injury to right palm, with perforation of the tendon sheath, seven weeks previously. Suppurative tenosynovitis from secondary infection through sinus tract.

Bacteriologic examination of this exudate revealed a pure culture of hemolytic staphylococcus aureus which grew well both aerobically and anaerobically. Upon cutting through the skin at the site of the sinus, there was encountered a gray, granulomatous mass of tissue, about 2 cm. in diameter, which extended to the fibrous tendon sheath which was also streaked with gray. Upon opening the sheath, seropurulent fluid was evacuated, and the tendons within the sheath showed grayish and black streaks. The fibrous tendon sheath in the finger also showed these grayish streaks and the vincula were similarly stained. There was slight violet coloration of the liquid in the digital part of the sheath. The granulomatous tissue and some of the gray tissue were removed, but complete removal was not attempted because of the complicating infection.

The postoperative course for the first few days was somewhat stormy and presented a picture which suggested a toxemia not entirely compatible with the evident infection.

Although the boy complained of pain in the finger, hand and forearm, there was no evidence of a spreading infection, the swelling was confined to the finger and metacarpophalangeal joint, and there was no lymphangitis, although the axillary nodes were tender. At no time did the temperature rise over 100.4° F. He developed upper abdominal distress and diffuse tenderness over the whole upper abdomen, anorexia was marked, he was listless and apathetic. He was not jaundiced, though the icterus index was 7.5. This situation persisted for about eight days, during which time he received large amounts of fluid, and 2,000 cc. of 10 per cent glucose was administered intravenously on two occasions.

After the eighth postoperative day the temperature came down to normal and the general condition improved except for the listlessness and anorexia which persisted for some six weeks. The incision healed slowly following the discharge of two large plugs of gray necrotic tissue, and was complete on May 27, 1939, one month after operation.

Pathologic Examination.—Microscopic: Dr. Frank B. Queen. The excised tissue



A B

FIG. 4.—Case 2: Photomicrograph of tissue removed at first operation. (A) Tissue from central portion of necrotic area shows dense mass of pigment and absence of any viable cells. (B) Tissue from more peripheral portion, still filled with pigment, some viable nuclei present. (×105)

showed a "necrobiosis of subcutaneous tissue due to foreign body (Fig. 4 A and B). The tissue is composed of necrobiotic material in which the hazy outlines of cells are seen, and apparently there has been a good deal of inflammation prior to the development of the necrosis, since in many fields the tissue seems excessively cellular. The material now stains purplish-blue and vague outlines of nuclei are seen in much of it. In addition, there are many masses of black pigment of variable size, which, when examined for distribution, seem to be more prevalent in the zones containing hyaline connective tissue than anywhere else. Sections from one of the blocks are better preserved than the others and, here, mononuclears seem to be the predominant type of cell."

Subsequent Course.—On July 26, 1939, two months after the incision had healed, and the boy had begun to work driving a car, a tender swelling appeared at the lateral end of the transverse palmar incision. It proved to be a small subcutaneous abscess which was opened and drained. Since it lay under the scar of the previous incision, occasion was taken to remove a thin piece of grayish skin and subcutaneous tissue for microscopic examination. The abscess healed rapidly following drainage and, except for its coincidental location with the previous injury, presented nothing extraordinary.

The microscopic sections are of interest since they show the hyperplastic changes in

the skin which may follow indelible injuries. Doctor Queen reported that "the epithelium is somewhat hyperplastic and hyperkeratinized (Fig. 5). Beneath it is the rather heavily vascular corium. There are masses of dark-staining, granular, blue-black pigment. None of these appears to be phagocytized as far as can be definitely determined. They lie in the interstices of the tissues and occasionally there seems to be some disintegrating cytoplasm about some of them. The connective tissue of the corium elsewhere is rather edematous and quite well vascularized. There is perivascular cuffing with lymphocytes and mononuclears."*



FIG. 5.—Case 2: Photomicrograph of epithelium removed at second operation, showing moderate hyperplasia and hyperkeratinization. Pigment diffusely scattered throughout corium, no evidence of phagocytosis. (×60)

* The indelible pencil in this case came from one of the well-known foreign pencil manufacturers. Chemical tests carried out on the pencil lead, by Dr. Chester Farmer, Professor of Chemistry, Northwestern University Medical School, indicated that the dye which it contained was methyl violet. An inquiry, sent to the New York office of the firm which manufactured the pencil, was answered briefly and noncommittally, with the assurance that to the best of their knowledge no injurious substance was contained in the pencil, but no information was given as to the actual dye used. It is interesting to note that Kuwahra, Erdheim, and others who experimented with similar pencils, had no hesitancy in naming the manufacturers and that the name of this firm appeared in the literature (Kuwahra) in this connection well over 35 years ago.

BIBLIOGRAPHY

[1] Anglesio, B.: Sulle ferite da matita copiativa. Infortun. e Traumat. Lav., 1, 33–39, 1935; abst. Zentralorgan f. d. gesamte Chir., 81, 566, 1937.

[2] Arce, J.: Blessures causées par les crayons d'aniline. Semana méd., 39, 213–219, 1932.

[3] Bechschoft–Nielson, P.: Tintenstiflverletzung. Ugeskr. Laeg., 95, 901–102, 1933; abst. Zentralorgan f. d. gesamte Chir., 64, 633, 1933.

[4] Bettazzi, G.: Sulle ferite da lapis copiativo. Policlinico Sez. Chir., 2, 501–505, 1928.

[5] Bianco, T.: Considerazioni sulla patologia e sul trattamento delle ferite de lapis copiativo. Arch. ital. di chir., 56, 178–188, 1939.

[6] Bravo, J., and Canedo, D.: Heridas par lápiz de anilina. Arch. de med., cirug. y especial, 16, 391–393, 1935; also in Actas Soc. de cirug. de Madrid, 4, 177–182, 1935.

[7] Brea, M. M.: Herida por lápiz tinta. Bol. del'inst. clin. Quir. Univ. Buenos Aires, 10, 210–211, 1934; also in Semana méd., 2, 120–121, 1934.

[8] Bride, T. M.: Perforation of the Orbit with an Indelible Pencil. Brit. Med. Jour., 2, 57, 1932.

[9] Bull, P.: Indelible Pencil Injuries. Norsk magazin for Laegevidenskahen, 84, 221, 1923.

[10] Buzzi, A., Costa, A. J., and Derqui, M. N.: Wounds of the Hand and Fingers Due to Aniline Pencils. Semana méd., 2, 1064–1068, 1929.

[11] Dalquen, P.: Die geweblichen Veränderungen bei Tintenstiftverletzungen. Inaug. Diss. Giessen, 1934; abst. Zentralorgan f. de gesamte Chir., 74, 396, 1935.

[12] Dejean, C.: Keratite par crayon d'aniline. Etude clinique et experimentale. La Presse méd., 41, 652, 1933.

[13] Delgado, R.: Heridas par lápiz de anilina., Lesiones consecutivas. Revista Med. del Rosario, 20, 609–616, 1930; also Semana méd., 1, 913–918, 1931.

[14] Erdheim, S.: Über Verletzungen mit Tintenstiften. Arch. f. klin. Chir., 106, 91–103, 1914.

Idem: Zur Pathologie und Therapie der Tintenstift—(Kopierstift) Verletzungen. Arch. f. klin. Chir., 113, 772–810, 1920.

[15] Ettore, E.: Sulle lesioni ossee da matite copiative—(Studio Sperim). Arch. di Ortop., 46, 687–707, 1930.

[16] Gartenmeister, R.: Ein Fall von Tintenstiftverletzung. Zentralbl. f. Chir., 53, 1687–1688, 1926.

[17] Gierlich, J.: Experimentelle Untersuchungen über Tintenstiftverletzungen. Deutsche Ztschr. f. d. gesamte gerichtliche Med., 25, 156–163, 1935.

[18] Glass, E.: Zur Tintenstift—Gewebsnekrose. Deutsche med. Wchnschr., 48, 1383, 1922.

Idem: Das Krankheitsbild der Tintenstift—Gewebsnekrose. Dermatol. Wchnschr., 79, 1585–1587, 1924.

[19] Glass, E., and Krüger, E.: Über Tintenstiftverletzungen bei Tier und Mensch. Experimentelle und klinische Studie, Deutsch. Ztschr. f. Chir., 189, 382–391, 1925.

Idem: Weitere experimentelle Forschungsergebnisse zu "Tintenstiftnekrose." Zentralbl. f. Chir., 2, 571–573, 1924.

[20] Glass, E.: Chemische bedingte nekrotisierende Panaritien. Zentralbl. f. Chir., 53, 2853–2855, 1926.

Idem: Bleistift und Tintenstift. Verschiedenes Verhalten in Bezug auf die Einheilung. Zentralbl. f. Chir., 58, 1770–1771, 1931.

Idem: Über die schnelle Entstehung und Ausbreitung der Tintenstiftnekrose. Deutsche med. Wchnschr., 61, 1234, 1935.

[21] Gräflin, A.: Experimentelle Untersuchungen über den schädlichen Einfluss von pulverförmigen Anilinfarben auf die Schleimhaut des Kaninchenauges. Ztschr. f. Augenheilk., 10, 193–205, 1903.

[22] Ilkoff, I.: Über Schädigungen des Verdauungstractus durch Kopierstiftminen. Deutsche med. Wchnschr., 56, 1132–1133, 1930.

[23] Iselin, M.: Les blessures de la main et des doigts par crayon d'aniline. La Presse méd., 35, 467, 1927.

Idem: Plaies par crayon d'aniline. Chirurgie de la main. Masson et Cie, 42–46. Paris, 1938.

[24] Jerusalem, M.: Case Presentation. Wien. klin. Wchnschr., 36, 211, 1923.

[25] Kuwahra, Y.: Experimentelle und Klinische Beiträge über die Einwirkung von Anilinfarben auf das Auge. Arch. f. Augenheilk., 49, 157–171, 1903.

[26] Lukjanov, A.: Indelible Pencil Injuries. Voenno—med. Z., 1, 29–37, 1930; abst. Zentralorgan f. d. gesamte Chir., 56, 618, 1932.

[27] Marshall: Perforation of Orbit with Aniline Pencil. Brit. Med. Jour., 1, 706, 1932.

[28] Marsiglia, G.: La lesioni da matite copiativa. Riforma med., 2, 1308–1313, 1928.

[29] Megnin and Abitboul: Necrose chimique par crayon d'aniline. Mem. l'Acad. de chir., Paris, 62, 1339–1340, 1936.

[30] Michon, M.: Plaie de la main par crayon d'aniline. Bull. Soc. de Chir., de Lyon, 1933.

Idem: Plaie de la main par crayon d'aniline. La Presse méd., 41, 826, 1933.

[31] Milch, H.: Indelible Ink-Pencil Injuries. ANNALS OF SURGERY, 87, 95–98, 1928.

[32] Patel: Case Report. La Presse méd., 41, 826, 1933.

[33] Perez, B.: Lesiones consecutivas a heridas con lapiz tinta. Bol. Inst. Clin. quir., Univ. Buenos Aires, 7, 435–458, 1931.

[34] Puoz, J. de: Über chemisch bedingte Gewebsschädigungen, speciell Tintenstiftnekrosen in ihrer klinischen und unfallmedizinischen Bedeutung. Schweiz. med. Wchnschr., 14, 1124–1129, 1933.

[34a] Rehn, L.: Blasengeschwülste bei Fuchsin-Arbeitern. Arch. f. klin. Chir., 50, 588–600, 1895.

[35] Sachs, O.: Klinische und experimentelle Untersuchungen über die Einwirkung von Anilinfarbstoffen auf die menschliche und tierische Haut. Arch. f. Dermatol. u. Syph., 116, 555–684, 1913.

[36] Sharlit, H.: Melanoma Caused by Indelible Pencil. Arch. Derm. and Syph., 37, 301–306, 1938.

[37] Torraca, L.: L'azione necrotizzante delle matite copiative e di alcuni colori di anilina. Arch. per le sci. med., 44, 283–297, 1922.

[38] Vogt, A.: Experimentelle Untersuchungen über die Bedeutung der chemischer Eigenschaften der basischen Anilinfarbstoffe für deren schädliche Wirkung auf die Augenschleimhaut. Ztschr. f. Augenheilk., 15, 58–72, 1906.

[39] Wilmoth, P.: Necrose aseptique par le crayon d'aniline. La Presse méd., 37, 700–701, 1929.

[40] Wolszczan, J.: Indelible Pencil Injuries. Chir. Narz. Ruchn., 3, 328–335, 1930; abst. Zentralorgan f. d. gesamte Chir., 53, 276, 1931.

[41] Zepponi, G.: Ferite da matita copiativa. Rinasc. med., 10, 449–450, 1933.

AMEBIASIS CUTIS

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THE PATHOLOGIC PROCESSES resulting from infestation with Endameba histolytica have attained considerable surgical significance. Althought amebiasis is usually considered to be a tropical disease, manifestations of it have been reported from all sections of the United States. Craig[1] examined 49,336 people from all parts of the United States for amebae and found 5,720 (11.6 per cent) to be infested. Ochsner and DeBakey[2] estimate that 500,000 to 1,000,000 people in this country are so affected.

The most common manifestations of amebiasis are the intestinal lesions and hepatic abscess.

One of the less common but most serious lesions due to amebae is ulceration and gangrene of the skin and subcutaneous tissues. Two such cases have been encountered in the Vanderbilt University Hospital. Only one of these cases recovered, which was due to the prompt recognition of the cause of the gangrene and the institution of specific treatment soon after entrance to the hospital.

Twenty-eight cases of gangrene and ulceration of the skin due to Endameba histolytica have been collected from the literature. All of these cases had associated visceral lesions and presented definite evidence that the lesions were due to Endameba histolytica. Reviewed cases not fulfilling these requirements are not included.

Ngai and Frazier[3] reviewed the literature in 1933. These authors included 27 cases in their report. Several of their cases which do not fulfill the above requirements are not included in this review. Since 1933, only six additional cases have been reported.

Nasse,[4] in 1891, was the first to describe this condition, but the term "amebiasis cutis" was first applied by Engman and Heithaus[5] in 1919. Nasse's case followed drainage of a liver abscess but motile amebae were not identified. Engman and Meleney,[6] in 1931, reported two cases of amebiasis cutis in which the characteristics of the Endameba histolytica were definitely identified. Meleney and Meleney[7] reported a case of extensive ulceration of perianal region in which complete bacteriologic as well as protozoologic studies were carried out. In this case the presence of the micro-aerophilic nonhemolytic streptococcus was definitely ruled out, showing that the skin changes were due entirely to Endameba histolytica.

As has been pointed out by Engman and Meleney,[6] the published cases fall into four groups. The classification is as follows:

(1) Cases following drainage of amebic abscess of the liver.

TABLE I

SYNOPSIS OF 28 CASES OF AMEBIASIS CUTIS COLLECTED FROM THE LITERATURE

No.	Author	Age	Sex	Previous Dysentery	Site	History	Smear	Microscopic Examination	Stools	Treatment	Course
1	Nasse, D.,[4] 1892	60	M.	No	Abd. wall	Abdominal pain; palpable epigastric mass. Surgical drainage liver abscess, followed in 7 days by progressive gangrene abdominal wall to area 4x5 cm.	Neg.	Pos.	Not exam.	Palliative. No specific therapy.	Progressive weight loss; high fever. Died.
2	Menetrier, M. P., and Touraine, M. H.,[15] 1908	23	M.	No	Abd. wall	Surgical drainage liver abscess, followed by progressive necrosis skin around incision.	Pos.	Neg.	?	?	Died.
3	Bassires, F.,[12] 1911	52	M.	No	Chest wall	Surgical drainage liver abscess, followed by gangrene chest wall. Lesion at time of death, 13x15 cm.	Pos.	Neg.	Pos.	Local application of antiseptics.	Progressive necrosis; marked drainage; profuse hemorrhage drainage site. Died.
4	Carini, A.,[22] 1912	37	M.	Yes	Abd. wall	Surgical drainage liver abscess. Smears positive for amebae. Drainage followed by progressive gangrene abdominal wall to area 10x15 cm.	Pos.	Neg.	Neg.	Surgical incision necrotic tissue to rectus muscle. Local application of quinine sulph.	Excised area healed. Well.
5	Carini, A.,[22] 1912	30	M.	Yes	Abd. wall	Surgical drainage liver abscess followed 20th p.o. day by gangrene edges of wound, and 27th p.o. day by extensive necrosis to rectus muscle, area 10x8 cm.	Pos.	Pos.	?	?	Progressive necrosis. Died.
6	Daborn and Heymann,[25] 1912	38	M.	Yes	Abd. wall	Surgical drainage liver abscess followed 10th p.o. day by necrosis of edges of incision.	Pos.	Pos.	Pos.	Actual cautery. Local application silver nitrate.	Progressive necrosis abdominal wall to lesion 3.5x6 cm.; high fever; marked diarrhea. Died.
7	Heymann and Ricou,[23] 1916	?	?	?	Abd. wall	Surgical drainage liver abscess. Necrosis skin edges; progressive gangrene abdominal wall following 11th p.o. day.	Pos.	?	?	Intravenous emetine hydrochloride. Actual cautery. Irrigation with quinine sol.	Local process ceased to spread. High fever continued. Died.
8	Kofoid, Boyers and Swezy,[32] 1924	?	?	?	Abd. wall and l. ex.	Surgical drainage liver abscess. Edges incision erythematous; concomitant erythematous spots lower extremities.	?	Pos.	?	?	Died. Autopsy: Sections from skin lesions showed Endameba histolytica.
9	Heimburger, L. F.,[27] 1925	39	M.	No	Rt. flank	Spontaneous rupture mass right flank. Persistent discharging fistula. Development ulcer site of drainage. Sinus tract communicated with cavity in liver.	Pos.	Pos.	Neg.	Emetine hydrochloride.	Amebae disappeared from lesion. Ulcer healed by granulation. Well.

TABLE I (*Continued*)

No.	Author	Age	Sex	Previous Dysentery	Site	History	Smear	Microscopic Examination	Stools	Treatment	Course
10	van Hoof, L.,[11] 1926	?	F.	Yes	Perianal reg.	Dysentery 10 yrs. prior to appearance of multiple ulcerations, with fistula, about anus.	Pos.	?	Neg.	Emetine hydrochloride.	Amebae disappeared from lesion, which rapidly healed. Well.
11	Tixier, Favre, Morenas and Petourand,[18] 1927	53	M.	Yes	Perianal reg.	Dysentery for years. For 6 yrs., ulcerated perianal skin lesions 6x7 cm. No demonstrable fistula.	Pos.	Pos.	Neg.	Emetine hydrochloride. Cautery excision.	Lesions healed rapidly. Well.
12	York and Adams,[33] 1928	?	M.	Yes	Abd. wall	Surgical drainage liver abscess. Necrotic skin and progressive gangrene abdominal wall.	Pos.	Pos.	Neg.	Emetine hydrochloride.	Necrotic area separated. Edema and redness disappeared. Uneventful recovery. Well.
13	Cole and Heidman,[21] 1929	34	M.	No	Abd. wall	History and physical findings of acute appendicitis. Appendicectomy, followed on 9th p.o. day by necrosis about wound and spreading gangrene.	Pos. ?	Pos. ?	Neg.	Emetine hydrochloride.	Emetine had no effect upon lesions. Cure effected by cautery excision. Well.
14	Marwits and van Steenis,[29] 1929	?	M.	No	Abd. wall	Drainage appendiceal abscess followed by spreading ulcerative process abdominal wall. Lesion 24x12 cm.	Pos.	?	Neg.	Emetine hydrochloride.	Ulcer healed. Well.
15	Marwits and van Steenis,[29] 1931	?	M.	No	Abd. wall	Perforated cecum due to intestinal (?) amebiasis. Pericecal abscess with spread to abdominal wall.	Pos.	?	Neg.	Emetine hydrochloride.	Lesion healed. Well.
16	Engman and Meleney,[6] 1931	51	M.	—	Abd. wall	History intestinal obstruction. Celiotomy. Resection of hepatic flexure colon because of ulceration and obstruction. Fecal fistula 7th p.o. day. Necrosis abdominal wall 2 mos. p.o. Rapid spread of lesion to 12x15 cm.	Pos.	Pos.	?	Emetine hydrochloride.	Lesion healed. Died 9 mos. p.o. from peritonitis due to soiling from fecal fistula. Died.
17	Engman and Meleney,[6] 1931	34	F.	Muc. colitis 3 yrs. Yes	Abd. wall	Pain r. l. q. Celiotomy with rupture of mass in r. l. q. Necrosis wound edges progressing to area 10x10 cm.	Neg.	Pos.	?	No specific therapy.	Progression of gangrenous process. Died.
18	Cheng, C. C.,[23] 1931	25	M.	No	Abd. wall	Ruptured liver abscess 5 mos. prior to admission, followed by ulcer abdominal wall which progressed to area 14x16 cm. Had kala-azar.	Pos.	Neg.	Neg.	Emetine hydrochloride.	Lesion healed rapidly. Skin graft. Well.

19	Taylor and Hunter,[21] 1932	40	M.	No	Abd. wall	Drainage of abscess abdominal wall followed by progressive gangrene.	Pos.	Neg.	?	Emetine hydrochloride. Cautery excision.	Lesion subsided. Healthy granulations. Smears negative for amebae. Well.
20	Kouri, Bolanos and Fuentes,[8] 1933	44	M.	Yes	Perianal reg.	Perianal fistula 10 yrs. Marked ulceration following incision and drainage.	?	Pos.	?	Deep x-ray therapy.	Died. Autopsy: Sections showed amebae in skin of lesions of buttocks.
21	Ngai and Frazier,[3] 1933	30	M.	Yes	Perianal reg.	Ulcers perianal region 20 days prior to admission. Ulcers about anus 4 cm. Proctoscopic examination showed ulcers of rectal mucosa.	Pos.	Pos.	Neg.	Saline compresses 2 wks. without tendency to heal. Emetine hydrochloride. Yatren compresses.	Healing of lesion 10 days after institution emetine. Well.
22	Ngai and Frazier,[3] 1933	43	F.	No	Perianal reg.	Ulcerative lesions vulva and anus; condylomatous lesions urethral orifice. Scrapings of latter positive for spirochetes. Positive Wassermann. No response to antileutic treatment.	Neg.	Pos.	Neg.	Biopsy revealed amebae. Patient failed to return for treatment. No emetine given.	Not followed.
23	Ngai and Frazier,[3] 1933	46	F.	Yes	Perianal reg.	Fungating cauliflower mass, 8x6 cm., anal region. Mass excised.	Neg.	Pos.	Neg.		Not followed.
24	Crawford, S.,[14] 1933	40	F.	No	Buttocks	Extensive ulceration cutaneous surfaces of buttocks, present 4 yrs.	Pos.	Pos.	Pos.	Excision. Emetine hydrochloride.	Active lesions persisted. Well.
25	Meleney and Meleney,[7] 1935	51	M.	Yes	Perianal reg.	Tender mass just lateral to anus, 1 mo.; rupture and discharge large quantity foul-smelling pus. Large ulcer over sacrum and buttocks.	Neg.	Pos.		Lesion excised. Emetine hydrochloride.	Lesion rapidly healed. Skin graft 21st day. Well.
26	Carini, A.,[22] 1936	37	M.	No	Perianal reg.	Furuncles anal region 2 yrs., with drainage thick yellow pus. Two large ulcerative lesions 5 cm. length each side anus.	Pos.	Pos.	Neg.	Local antiseptics. Emetine hydrochloride.	Amebae rapidly disappeared following 6 injections emetine. Lesions completely healed. Well.
27	Manson-Bahr,[31] 1937	25	M.	No	Abd. wall	Sigmoidoscopy following rectal hemorrhage showed extensive ulceration. Colostomy. Progressive gangrene abdominal wall.	Pos.	Pos.	Pos.	Emetine. Yatren.	Wound cleared. Necrotic tissue sloughed. Well.
28	Fingerland, A.,[13] 1939	54	M.	Yes	Abd. wall	Dysentery for years. Signs intestinal obstruction on admission. Celiotomy. Annular constriction sigmoid. Colostomy. Onset progressive gangrene abdominal wall to area 20 cm. 2 mo. p.o.	Neg.	Pos.	Pos.		Progressively worse, with spread of gangrene. Died.

(2) Those following drainage of ruptured viscus (appendix, fecal fistula, pericolic abscess, colostomy following resection of large bowel).

(3) Those cases with involvement of perianal skin associated with amebic colitis.

(4) Those cases without any direct connection with viscera (this group is not considered in this report).

The collected cases are tabulated in Table I. Of the authentic cases in the literature, 15 recovered, 11 died and two were not followed. The first group contained the greatest number of cases and the highest mortality rate (Table II). In seven of the 11 cases that died, there was extensive gangrene of the abdominal wall following drainage of a liver abscess. The remaining four deaths were caused by gangrene of abdominal wall following a colostomy for obstruction, drainage of a pericolic abscess, a fecal fistula resulting from a resection of the large bowel for what was thought to be a carcinoma but proved to be a "granuloma," and extensive involvement of the perianal skin associated with a severe amebic colitis.

TABLE II

MORTALITY RATE

Group	No. Cases	Died	Well	Not Followed	Mortality Rate
I.....	12	7	5	0	58.3%
II.....	7	3	4	0	42.8%
III.....	9	1	6	2	11.1%

Of the 15 cases in the literature which recovered, six had involvement of the perianal skin and subcutaneous tissue. Five cases followed drainage of a liver abscess, one followed a colostomy for ulcerative colitis, two cases followed drainage of a ruptured appendix, and one case followed drainage of a perforated diverticulum of the large bowel. The two cases which were not followed had involvement of only the perianal skin.

CASE REPORTS

Case 1.—A. W., colored, female, age 63, a native of Tennessee, entered the Surgical Service of the Vanderbilt University Hospital, November 6, 1933, with the chief complaint of vague abdominal pain of six months' duration. There had been no nausea, vomiting nor diarrhea. Two months before admission she had noticed a mass in the left upper abdominal quadrant, which had subsequently become tender. The mass gradually increased in size. There had been no chills, although she stated positively that she had fever. She had never been out of the state of Tennessee. The remainder of her history was not remarkable.

Physical Examination.—The patient was an extremely ill, poorly nourished, elderly colored woman. Temperature 103° F., pulse 140, respirations 30. The skin was dry and there was evidence of marked loss of weight. Examination of the abdomen revealed a large, firm, tender, fluctuant mass in the left upper abdominal quadrant. The remainder of the examination was not remarkable.

Course in Hospital.—Repeated examinations of the stools were negative for amebae, although the mass was suspected of being an amebic abscess. Her temperature rose daily to 104° F., and she rapidly became worse. On the third hospital day, celiotomy was carried out through a left rectus incision over the mass. A large quantity of foul-smelling, grayish pus was evacuated and a drain was placed in the cavity. Cultures at

this time were positive for the colon bacillus, but cultures for anaerobic organisms were negative. No amebae were found in smears made from the pus. After drainage, the

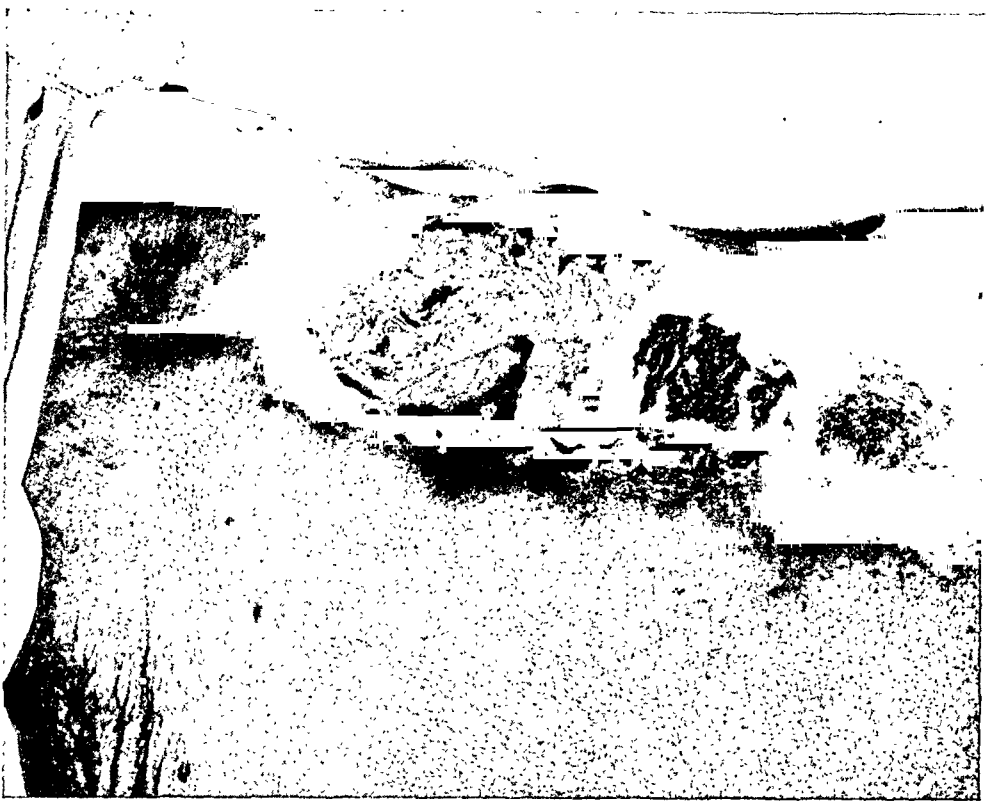


FIG. 1.—Case 1: Photograph of the lesion. In this case, the ulcerated area is not as extensive as in Case 2, but the gangrenous edge of the ulcer can be plainly seen.

temperature immediately fell, and with transfusions and supportive treatment she rapidly improved.

On the seventh postoperative day, necrosis of the wound was noticed. This rapidly progressed until there was a wide area of gangrene about the draining sinus at the

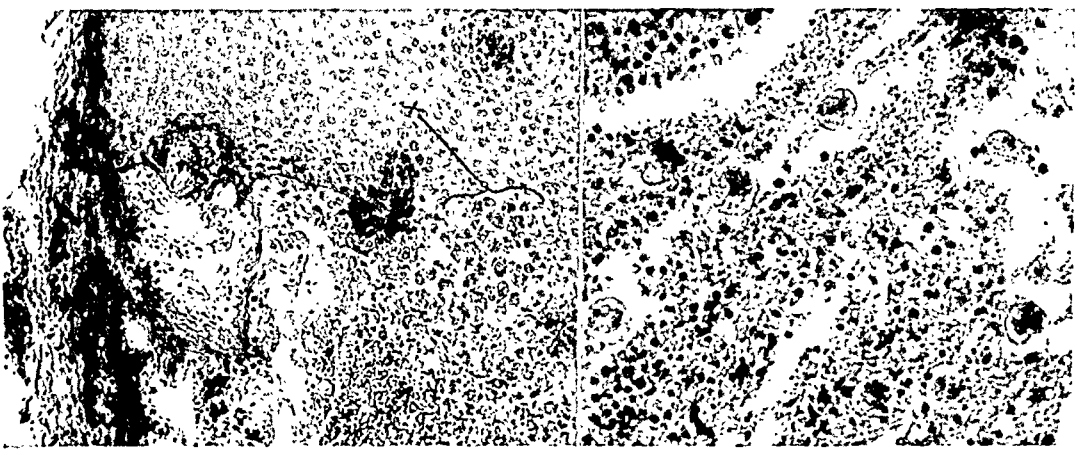


FIG. 2.—Case 1: Photomicrograph of section of skin taken from the periphery of the ulcerated area. The amebae can be seen to be actually invading the epithelium at point indicated by the bracket marked X.

FIG. 3.—Case 1: Photomicrograph showing a section taken from the base of the ulcer. The nuclei in the amebae are prominent. (High magnification.)

bottom of a deep crater, the base of which was bathed in foul-smelling pus (Fig. 1). Around the wide gangrenous area there was an area of erythema. For the first time

motile forms of Endameba histolytica were found. Biopsy of the skin at periphery of ulcerated area revealed the presence of amebae on microscopic section (Figs 2 and 3). The patient was immediately given emetine hydrochloride 0 03 Gm. twice daily. This was administered over a period of 16 days. The wound was irrigated with Yatren and with Dakin's solution. An extensive débridement was carried out and the wound edges were beveled. Frequent electrocardiographic tracings were made while the emetine was being administered. In spite of this specific treatment, blood transfusions and supportive measures, she lost weight and strength and expired on the fiftieth hospital day. Autopsy was not obtained. Amebae were never found in the stools.

Case 2.—D. E, white, male, age 34, a bricklayer and a native and resident of

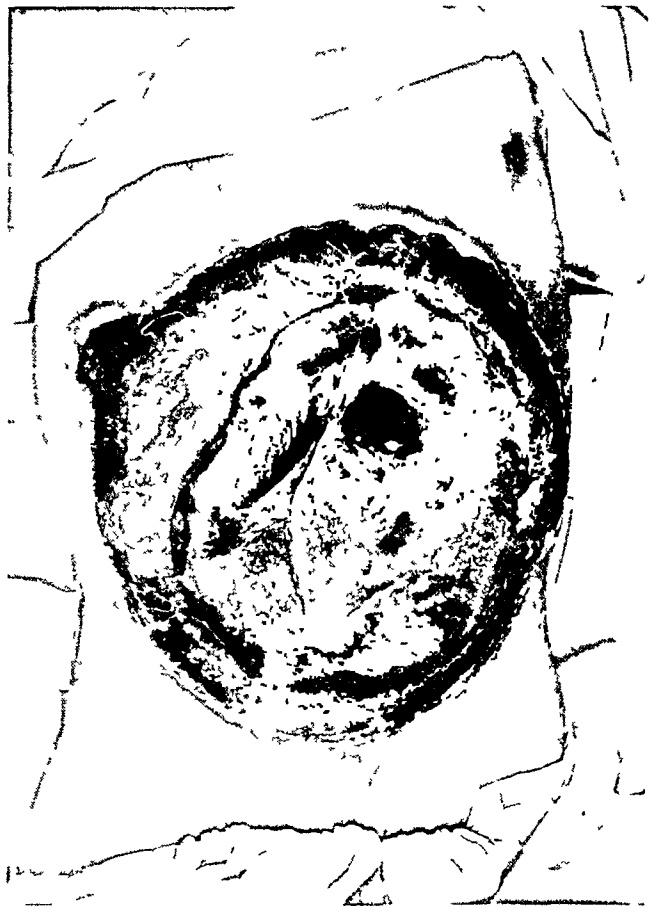


FIG 4.—Case 2. Photograph of the gangrenous area. Here, the massive involvement of the anterior abdominal wall is shown as well as the overhanging edges of the crater.

Tennessee, was admitted to the Surgical Service of Vanderbilt University Hospital August 15, 1939. He was referred because of "sloughing of the abdominal wall." Six months prior to admission he had experienced sudden sharp pain in the right upper abdominal quadrant. The pain remained localized and was unaccompanied by nausea and vomiting. The pain subsided and left him with tenderness in the right upper abdominal quadrant which persisted for about two weeks. Three months later the pain reappeared and became a constant dull ache. Three weeks after reappearance of the pain the patient himself felt a mass in the epigastrium. The mass continued to increase in size and became very tender. There were no concomitant gastro-intestinal symptoms. Two and one-half months later, celiotomy was performed by his local physician, who states that "a right

rectus incision was made over the mass and about 1,500 cc. of thick, pinkish, odorless material was evacuated. The wound was closed with drainage and the patient was discharged two weeks later, still draining profusely."

Three weeks after operation the edges of the wound became gangrenous and this

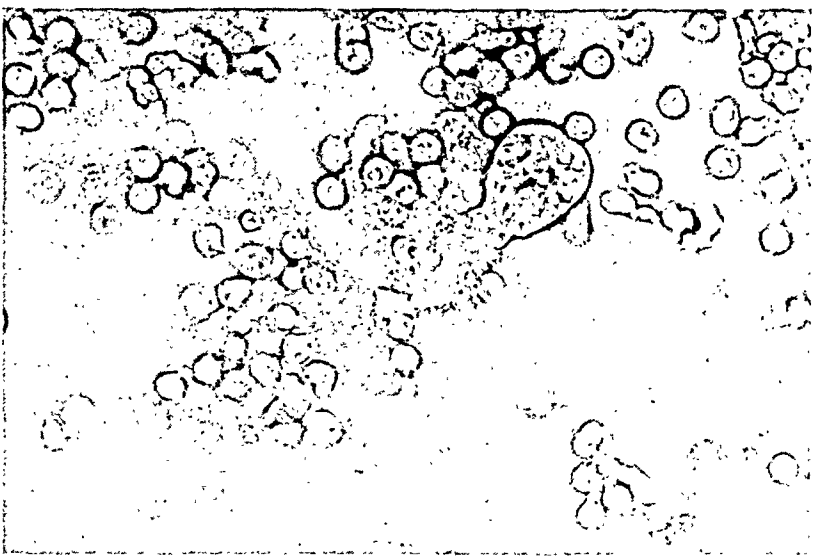


FIG. 5.—Case 2: A motile form of Endameba histolytica recovered from the exudate. The ameba has ingested numerous red blood cells and cellular debris.

process spread rapidly over almost the entire abdominal wall. His condition became rapidly worse, temperature became elevated, he lost weight and strength and became delirious. He was admitted to Vanderbilt University Hospital six weeks after the onset of gangrene of the abdominal wall.

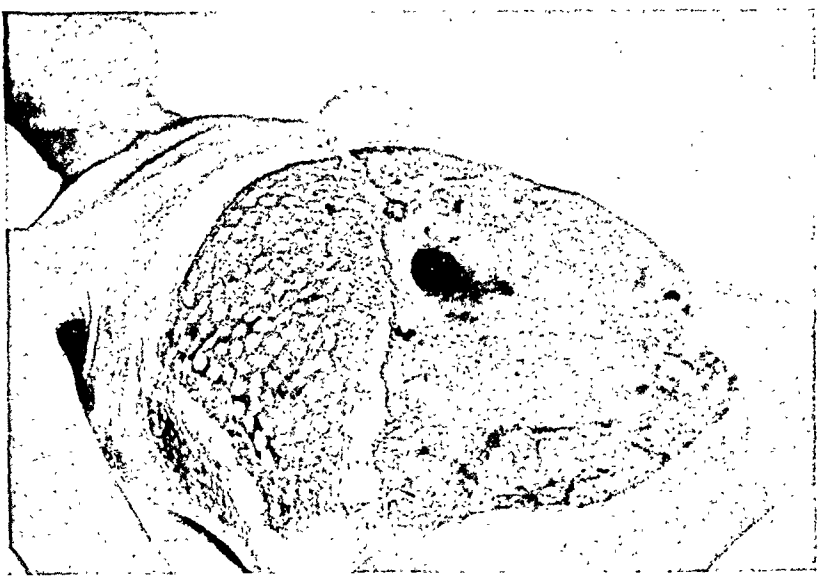


FIG. 6.—Case 2: After extensive débridement. The granulating area has been partially grafted; in spite of that amebae can still be recovered from the draining sinus.

Physical Examination.—The patient was an extremely ill, emaciated, semicomatose, young white male. Temperature 101.2° F., pulse 132, respirations 32. The skin was dry and pale. There was almost complete loss of subcutaneous tissue. Remainder of physical examination was not remarkable except for the abdominal wall. Here, there was an area of ulceration extending from the xiphoid process almost to the symphysis

pubis and laterally to the anterior axillary lines, measuring 22x18 cm. in diameter. The edges of the ulcer were irregular and overhanging. The surrounding skin was black, dry and parchment-like in texture, with an advancing "halo" of deep red, shading gradually into the color of the normal skin. The base of the ulcer was bathed in thick yellowish-

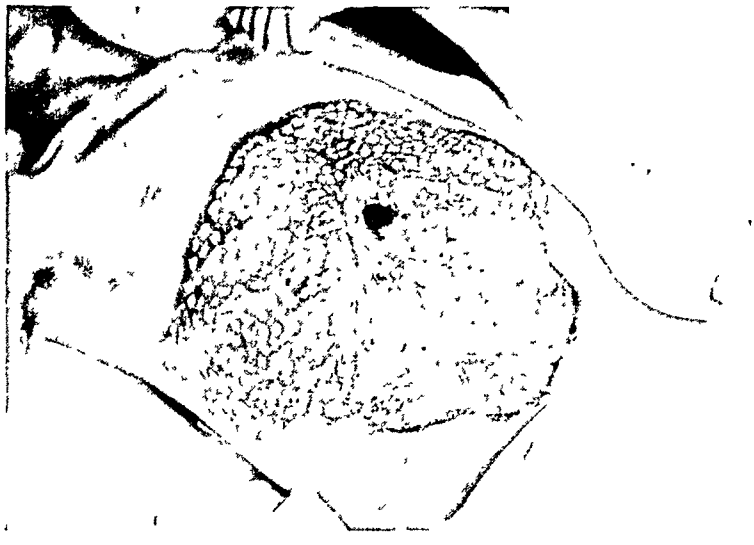


FIG 7.—Case 2. Showing further grafting. Exudate from the sinus still contains amebae.

green pus which gave off an acrid unpleasant odor. On clearing the crater of purulent material, both rectus abdominalis muscles could be plainly seen, the anterior rectus sheath had been completely digested. In the midline just below the xiphoid and in the superior portion of the crater there was a sinus about 2x3 cm. in diameter which would admit

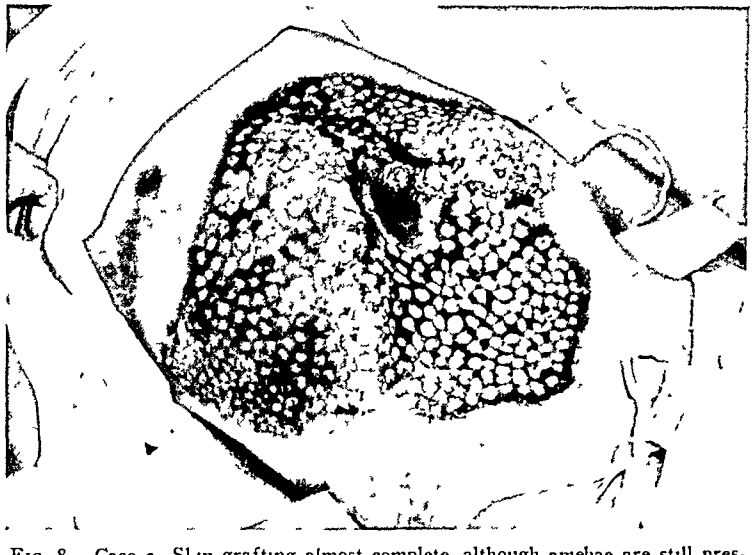


FIG 8.—Case 2. Skin grafting almost complete, although amebae are still present. They did not affect the skin transplants.

the index finger for a distance of 4 cm. (Fig. 4). From this sinus exuded yellow bile. The remainder of the physical examination was not remarkable.

Course in Hospital.—Several massive blood transfusions were administered with slight improvement in the general condition. Infestation with Endameba histolytica was

suspected from the very first, but only on the seventh hospital day were the organisms found (Fig. 5). Cultures were positive for an anaerobic streptococcus. Amebae were found at first only under the overhanging edges of the ulcer. As soon as the diagnosis was made, the patient was immediately given emetine hydrochloride (0.065 Gm. intramuscularly daily for 12 days). Amebae were *never* found in the stools. On the tenth hospital day, as soon as his general condition would permit, an extensive débridement of all the necrotic tissue was carried out. This was a rather formidable procedure as it entailed removable of a tremendous amount of tissue. Bleeding was controlled with catgut ligatures and hot wet packs and he was returned to the ward in only fair condition.

The sinus continued to discharge purulent material and smears were positive for amebae. Irrigation of the wound was begun with Dakin's solution and the sinus itself, which continued to discharge bile-stained material, was irrigated with carbazone.

As soon as there was evidence of granulation tissue in the wound, small, deep grafts were applied to the defect at frequent intervals (Figs. 6, 7, 8, 9). It was possible to cover almost the entire area with epithelium although the discharge from the sinus was still positive for Endameba histolytica. The skin transplants were not affected by the organisms.

The patient began to gain weight and strength and was discharged perfectly well after 115 hospital days, with instructions to return at a later date for excision of the grafted area (small, deep grafts) and application of split-grafts.



FIG. 9.—Case 2: Skin grafting has been completed and the sinus has completely healed. The state of nutrition of the patient has improved tremendously.

COMMENT.—The most striking action of the Endameba histolytica is lysis of the tissues without a great deal of tissue reaction. The picture is greatly altered, however, when amebae attack the skin around a discharging sinus. The characteristics of this disease are exemplified by Case 2 (Fig. 4) where one sees the rapidly spreading ulcerative process, an irregular crater with overhanging gangrenous edges, "an advancing 'halo' beyond the margin of the ulcer which varies in color from a dusky red through various shades until it merges gradually with the color of the normal skin" (Engman and Meleney[6]). The base of the ulcer is bathed in pus and frequently partially digested anatomic structures may be identified.

Secondary infection of the involved tissue with bacteria plays an important part in the progress of the disease. It is well known that secondary infection of an amebic abscess of the liver greatly increases the gravity of the prognosis. This factor holds true also for amebic ulceration of the skin. In Case 1, the course was complicated by the colon bacillus; in Case 2, an anaerobic streptococcus was present which disappeared soon after irrigations with Dakin's fluid were begun.

From the two foregoing cases and those reported in the literature, it may be seen that involvement of the skin and subcutaneous tissues by Endameba histolytica is an extremely grave complication.

The most important factor in care of amebic ulceration of the skin is *early recognition* of the cause of the disease. In many instances amebiasis has been suspected and repeated examinations of the exudate have been made without finding amebae. It must be borne in mind that smears taken from the discharging sinus will frequently show no amebae while bits of necrotic tissue taken from the undermined, overhanging edges of the crater will yield numerous motile forms.

When the pathologic picture described above is encountered, it is justifiable to administer emetine even if smears are negative for amebae. However, it is important to differentiate this type of skin involvement from progressive postoperative synergistic gangrene caused by micro-aerophilic nonhemolytic streptococcus.

Next in importance to the early administration of emetine is thorough débridement of the involved tissue.

Gangrene of the skin due to amebiasis is almost universally seen in ill-nourished people. Consequently, one must exercise a great deal of thought and patience in their postoperative care. Their diet must be adequate in calories and especially high in protein content, in an effort to combat the hypoproteinemia that they often present. As hospitalization extends over a long period of time, the administration of vitamins is of great value. These patients are usually anemic so that the frequent administration of whole blood is very valuable. Administration of serum or plasma is also helpful in elevating low serum proteins. Skin grafts should be applied to granulating areas as soon as possible.

SUMMARY

Two cases of gangrene and ulceration of the skin of the anterior abdominal wall due to infestation with Endameba histolytica have been presented.

Case 1 was an elderly negress, who developed gangrene of the skin following drainage of a liver abscess. She died on the fiftieth postoperative day in spite of administration of emetine hydrochloride and débridement of the gangrenous tissue. The liver abscess was secondarily infected with the colon bacillus.

Case 2 was a young white male, who also developed very extensive gangrene and ulceration of the abdominal wall subsequent to drainage of a liver

abscess. On the seventh hospital day, motile forms of Endameba histolytica were found and he was given emetine hydrochloride, and extensive débridement of old devitalized tissue was undertaken. The wound granulated and skin grafts were applied. He was discharged perfectly well. In neither of these cases were amebae found in the stools.

A brief résumé of the literature is given. Twenty-eight authentic cases of amebiasis of the skin which were in association with visceral lesions have been collected. Fifteen of these cases recovered, 11 expired, and two were not followed.

Early recognition of the etiology of the disease, early administration of emetine, and extensive débridement of the affected tissue has been emphasized.

REFERENCES

[1] Craig, C. F.: Amebiasis and Amebic Dysentery. Springfield, Charles C. Thomas, 1934.
[2] Ochsner, A., and DeBakey, M.: Surgical Consideration of Amebiasis. Int. Abst. of Surg. (Surg., Gynec., and Obstet.), 69, 392, 1939.
[3] Ngai, S. K., and Frazier, C. N.: Cutaneous Amoebiasis: A Review and a Report of Three Cases Observed in North China. China Med. Jour., 47, 1154, 1933.
[4] Nasse, D.: Über einen Amöbenbefund bei Leberabscessen, Dysenterie und Nosocomialgangrän. Arch. f. klin. Chir., 43, 40, 1892.
[5] Engman, M. F., and Heithaus, A. S.: Amebiasis Cutis. J. Cutan. Dis. incl. Syph., 37, 715, 1919.
[6] Engman, M. F., Jr., and Meleney, H. E.: Amoebiasis Cutis. Report of Two Cases. Arch. Dermat. and Syph., 24, 1, 1931.
[7] Meleney, F. L., and Meleney, H. E.: Gangrene of the Buttock, Perineum and Scrotum Due to Endamoeba Histolytica. Arch. Surg., 30, 980, 1935.
[8] Kouri, P., Bolanos, J. M., and Fuentes, C. Rodriquez: Amebiasis cutánea por Entameba histolitica. Reporte de un caso personal, especialmente estudiado desde el punto de nista histologico y protozoologico. Rev. de med. y cirug. de la Habana, 38, 83, 1933.
[9] Meleney, F. L.: A Differential Diagnosis Between Certain Types of Infectious Gangrene of the Skin. Surg., Gynec., and Obstet., 56, 847, 1933.
[10] Dobell, C., and O'Connor, F. W.: The Intestinal Protozoa of Man. New York, William Wood and Co., 1921.
[11] van Hoof, L.: Abcés, fistules et ulcéres d'orgine amibienne. Ann. Soc. belge de méd. trop., 6, 45, 1926.
[12] Bassires, F.: Abcés amibien du foie et phagédénisme cutané amibien post-opératoire; association staphlococcique sécondaire. Arch. de Méd. et Pharm. Mil., 57, 256, 1911.
[13] Fingerland, A.: Amibiase cutanée (Contribution a l'etiologe de la gangréne post-opératoire progressive de la peau). Bull. Soc. franc. de dermat. et syph., 46, 903, 1939.
[14] Crawford, S.: Amebiasis Cutis; Report of Case. Arch. Dermat. and Syph., 28, 363, 1933.
[15] Menetrier, M. P., and Touraine, M. H.: Abcés ambibien du foil. Phagédénisme cutané ambibien. Bull. Soc. Méd. dos Hôpitaux de Paris, 25, 905, 1908.
[16] Runyan, R. W., and Herrick, A. B.: Surgical Complications and Treatment of Intestinal Amebiasis. Proc. Internat. Conf. on Health Prob. in Tropical Amer., p. 345, 1924.
[17] Straub, M.: Amoebiasis Penis. Geneesk. Tijdschr. v. Nederl-dudie, 64, 989, 1924. Abst. Trop. Dis. Bull., 22, 368, 1925.
[18] Tixier, L., Favre, M., Morenas, E., and Petourand, C.: Amibe dysentérique et ulcérations cutanées. Ann. de Dermat. et Syph., 8, 521, 1927.

[19] Meleney, F. F.: Bacterial Synergism in Disease Processes, with Confirmation of the Synergistic Bacterial Etiology of a Certain Type of Progressive Gangrene of the Abdominal Wall. ANNALS OF SURGERY, 94, 961, 1931.

[20] Touraine, A., and Duperat, R.: Lámibiase cutanée. Abst. Bullétin Soc. franc. de dermat. et syph., 46, 882, 1939.

[21] Taylor, L., and Hunter, O. B.: Progressive Ulceration of the Abdominal Wall with Report of a Case. Trans. Am. Therap. Soc., 32, 76, 1932.

[22] Carini, A.: Phagédénisme cutane ambibien. Bull. Soc. path. exot., 5, 216, 1912.

Idem: Un autre cas de phagédénisme cutane amibien. Bull. Soc. path. exot., 5, 799, 1912.

Idem: ibid., 29, 584, 1936.

[23] Chéng, C. C.: Cutaneous Amoebiasis Resulting from a Ruptured Liver Abscess Coincident with Kala-Azar: Report of a Case. China Med. Jour., 45, 350, 1931.

[24] Cole, W. H., and Heidman, M. L.: Amoebic Ulcer of Abdominal Wall Following Appendectomy with Drainage: Report of a Case. J.A.M.A., 92, 537, 1929.

[25] Daborn and Heymann: Abcés amibien du foie swivi de phagédénisme de la plaie opératoire et d'abcés cutané ambibien. Bull. Soc. Méd.-Chirurg. de l'Indo-Chine, 3, 518, 1912.

[26] Gauducheau, A.: Observations sur quelques entamibes. Bull. Soc. Méd.-Chirurg. de l'Indo-Chine, 3, 525, 1912. Abst. Trop. Dis. Bull., 1, 182, 1912–1913.

[27] Heimburger, L. F.: Amoebiasis Cutis with a Survey of the Medical Literature to Date. Arch. Dermat. and Syph., 11, 49, 1925.

[28] Heymann and Ricou: Un cas de phagédénisme cutané amibien. Bull. Soc. Méd.-Chirurg. de l'Indo-Chine, 7, 64, 1916. Abst. Trop. Dis. Bull., 12, 10, 1918.

[29] Marwits, E. L., and van Steenis, P. B.: Case of Amebiasis Cutis after Incision of Pericecal Abscess. Urol. and Cutan. Rev., 35, 313, 1931.

[30] Maxwell, J. L.: Fistulous Diseases of the Buttocks: A Clinical Entity. Trans. Soc. Trop. Med. and Hyg., 6, 50, 1912.

[31] Manson-Bahr, P.: Amoebic Invasion of Skin and Subcutaneous Tissues. Tr. Roy. Soc. Trop. Med. and Hyg., 32, 223, 1938.

[32] Kofoid, C. A., Boyers, L. M., and Swezy, O.: Systemic Infections by Endamoeba Dysenteriae. Proc. Internat. Conf. on Health Prob. in Tropical Amer., p. 390, 1924.

[33] Yorke, W., and Adams, A. R. D.: Tr. Roy. Soc. Trop. Med. and Hyg., 22, 7, 1928.

BRIEF COMMUNICATION AND CASE REPORT

FREE TRANSPLANTATION OF FAT FOR BRONCHO-PULMONARY CAVITY*

CASE REPORT

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NEW YORK, N. Y.

Case Report.—J. E., male, age 62, was first admitted to Mount Sinai Hospital, July 18, 1938, with the history of cough and purulent expectoration of seven months' duration. There was also some loss in weight and increasing dyspnea. For two or more weeks before admission, there had been fever and pronounced chest pain. This history of a seven months' illness was preceded by a vague history of having "swallowed a bone." The roentgenogram revealed infiltration in the left lower lobe with a series of pleural fluid levels. By bronchoscopy, much foul pus and fragments of chicken bone were evacuated from the lower lobe.

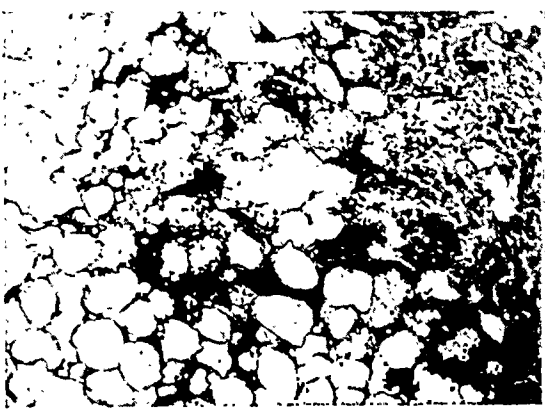


FIG. 1

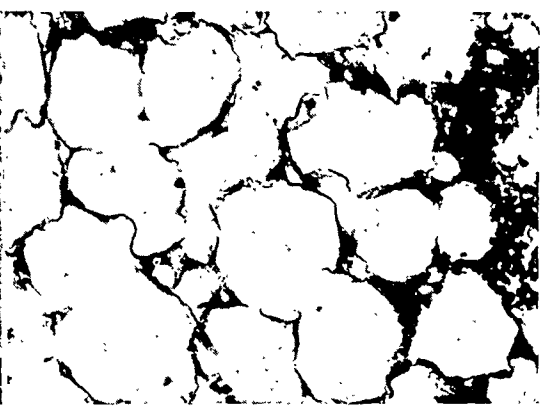


FIG. 2

FIGS. 1 and 2.—Photomicrographs of a section of the fat graft, removed from the wound 22 days after transplantation. (Low and high powers, respectively.)

Fever continued after the bronchoscopic treatment, but the cough became much reduced and the foul odor became faint. A roentgenogram showed no substantial change. Accordingly, operation was performed for encapsulated pyopneumothorax.

Operation.—Collections of foul pus in the pleura were evacuated through a postero-lateral thoracic approach. Multiple perforated pulmonary abscesses comprised the floor of the pyopneumothorax. Several dilated bronchial orifices opened into the wall of the pulmonary cavity. The picture, therefore, was that of a classic "lattice-lung."

The empyema cavity reduced in size progressively after operation. The "lattice-lung" persisted. The patient was discharged with a clean wound and a tube in place leading to the bronchopulmonary cavities.

He was readmitted to the hospital, January, 1939, for closure of the bronchopulmonary cavity. Except for a slight cough he was symptom free. The wound was clean. No infiltration of the lung was invisible in the roentgenogram. By bronchoscopy, there was a

* Presented before the New York Surgical Society, April 26, 1939. Submitted for publication July 7, 1939.

slight amount of secretion in the left main bronchus. The situation thus being satisfactory, transplantation of fat was proceeded with.

Second Operation.—January 3, 1939: The edges of the wound were freshened, the skin mobilized and the roof of the pulmonary cavity split open. The lesion was a typical bronchopulmonary cavity, about one and three-quarter inches in each diameter. There were a number of blowing bronchial fistulae. A mass of fat, of about these proportions, was removed subcutaneously from above the iliac crest and placed into the cavity. It fitted snugly. The graft was held in place by approximating the fibrous tissue which roofed the cavity and the skin by interrupted sutures. On the sixth postoperative day, the sutures were removed, and the wound appeared healed. Two days later, however, a partial separation of the skin was noted. The graft was visible in the depths. There was no bronchial fistula. On the twelfth day after operation, the graft was still seen to be in place, despite the fact that the wound was partly open. No bronchial fistula was present. On the seventeenth day after operation, the graft was seen to be still in place, and was adherent. Granulation tissue partly covered the transplant. There was no bronchial fistula. A specimen of the graft was removed for microscopic examination on the twenty-second day (Figs. 1 and 2). The wound healed not long afterward, and has remained healed. A roentgenogram demonstrated the absence of pulmonary infiltration after operation. The pathologic report of the specimen of the graft which was removed was: "Fat tissue and fibrous tissue connected with granulation tissue. The fat tissue is not necrotic."

DISCUSSION.—DR. CARL EGGERS (New York) said that he had had the pleasure of discussing Doctor Neuhof's original presentation of this subject before the American Thoracic Society two years ago. At that time, Doctor Neuhof had quite a series of cases and reported excellent results, similar to that obtained in the present instance. Doctor Neuhof stated then that the conception of transplantation of fat into a cavity which is partly lined with epithelium, and which is perhaps even moderately infected, did not agree with the ideas he had concerning tissue transplantation, and that it was a rather empiric method. Nevertheless, the facts are irrefutable, in that the majority of cases—17 were reported by Doctor Neuhof at the time—were healed, all except three which were failures, and three which were imperfectly healed. The question came up of what becomes of such a clean fat graft when transplanted into a cavity lined with epithelium; although it may be surgically clean it is not actually sterile. That question is still open, and is rather interesting in view of the present case presentation in which instance Doctor Neuhof reopened the wound, or in which the wound opened itself, and he had occasion to study the graft *in situ* some time after transplantation. He found that—contrary to one's expectation—the graft had actually "taken," and was being vascularized. Doctor Eggers said he doubted such a possibility at the time of the original presentation two years ago. Doctor Neuhof himself felt that probably the graft would not live but would gradually become absorbed, but, while in there, would tend to obliterate the cavity and also favor obliteration of the bronchi. Such a viewpoint was also held by Doctor Churchill at the time. When one realizes the difficulty of closing these cavities by ordinary surgical methods, one learns to appreciate any new procedure that promises results. One probably has to assume that the fat, which molds itself entirely into the cavity, actually does block the bronchi and that vascularization gradually takes place.

Some of these cavities can be obliterated if one brings about favorable conditions for healing; for instance, if one immobilizes the lung sufficiently and excises the thick fibrotic margins and perhaps even approximates the margins of the lung by suture, and then puts a muscular or subcutaneous tissue flap with skin over it. It is well for one who may have a case of this type to operate

upon, to bear both methods in mind. In very rebellious cases resection of the lobe may be indicated.

DOCTOR NEUHOF (closing): As Doctor Eggers implied, the operative procedure of transplantation of fat was empirically conceived. Even at the present time, when I have had a number of successful results, I feel that there is no logical basis for the operation. I thought of it only as an attempt at a short-cut in the first case because nothing else seemed to be feasible in a small child, who was just convalescing from a pneumonotomy and drainage of an unusually large pulmonary abscess.

Concerning the question of actual viability of these fat grafts, all I can say is that I had assumed that they acted only as scaffolds for the ingrowth of connective tissue and underwent gradual and progressive degeneration and absorption. When, however, as in this case, the specimen reveals viability even in the presence of an unsatisfactory set-up for viability, one may have to change one's viewpoint as to degeneration and disappearance of the graft.

Doctor Eggers has assumed that pulmonary cavities after drainage of abscesses become completely lined with epithelium. If this assumption were entirely correct, then a free fat graft or any other tissue graft or tissue flap should not be prone to "take." Although I have no proof, it is my conviction that these cavities are only partly lined with epithelium, and that, here and there, there are areas of granulation tissue. It seems to me that it is from these areas which are not epithelialized that there are sent forth vascular sprouts which represent the first stage of the maintenance of nourishment of the graft.

FORUM

(Articles published in the ANNALS OF SURGERY *do not necessarily represent the opinions of the editors, even though they are selected and published with editorial approval. Likewise, the editors may not necessarily be in agreement with correspondents whose communications are important if only because they present stimulating opposition. Since this impartial point of view is vital to progress in science, the* ANNALS OF SURGERY *offers this forum for pertinent discussions of reasonable length.—*ED.)

Re: New Incision for Closed Space Infection (Felon) Involving Distal Phalanx of Finger:—by Jerome J. Weiner, M.D. (Annals of Surgery, 111, 126-134, Jan., 1940)

FREDERICK CHRISTOPHER, M.D., EVANSTON, ILL.:

"First, I would strongly advise against amputation of the tuft of the distal phalanx, no matter whether it seems to be involved in infection or not. If osteomyelitis has developed it would seem far better to me to wait for sequestration. Regeneration of the phalanx will usually occur. Second, I think it very important not to damage the periosteum of the distal phalanx in any surgical procedure. The incision should be limited to the soft parts. Third, I believe that removal of the nail is unnecessary and painful and that it prolongs disability. Fourth, I believe that making the incision in the highly vascularized area of the nail bed is unwise and unnecessary. Once the correct diagnosis of felon has been made, it seems to me that the chief therapeutic indication is the relief of tension, which, if unrelieved, may invite necrosis of some of the distal phalanx. The relief of tension is also important to permit drainage of the abscess and to relieve pain. For this purpose, in my opinion, the hockey-stick incision is by far the best, and should not be of such depth as to nick the periosteum. The high incidence of felon and the prolonged morbidity even with proper treatment make this really an important question."

SUMNER L. KOCH, M.D., CHICAGO:

"Doctor Weiner's suggestions as to the treatment of felon seem to me to violate the first law of surgery, 'Do no harm,' on every count. To avulse the nail is not a simple injury; it requires from five to seven weeks, sometimes longer, for the formation of a new nail. Why one should voluntarily add this not trivial and totally unnecessary injury to the finger with an infection in the anterior closed space is difficult to comprehend. Furthermore, an incision through the nail bed, as depicted in Plate I, No. 3, would almost invariably lead to a fissured and deformed nail. Bone involvement often occurs following infection of the anterior closed space, but the patient will recover most rapidly and certainly if the soft tissues are drained adequately and the bone is left alone. To amputate the tip of the phalanx and expose haversian canals and bone cells to infection may lead to the very involvement that is most likely to result in long-delayed healing and loss of bone substance. That such a complication actually did take place following operation in the third case, reported by Doctor Weiner, is suggested by a comparison of Figures 10 and 11. While in some cases the abscess may be close to the tip of the finger, in many others, it lies at some distance from it. To cut the normal and uninfected tissue to reach an abscess which could be drained by an incision directly over it does not seem wise or commendable. Finally to entrust the care of an infected wound to the patient and instruct him 'to soak the finger in hot boric solution every two hours for 20 minutes' is a fairly certain way of adding further infection to the open wound."

HUBLEY R. OWEN, M.D., PHILADELPHIA:

" . . . I do think that Doctor Weiner's article . . . on the subject of The Treatment of Felons is terrible, and exactly contrary to all of the teaching of Kanavel, which we have tried to follow. The idea of locally infiltrating 1% novocain into a thumb which was 'tense, tender and hot' shows a very limited knowledge of surgery, and I do not believe this article should have been published in the ANNALS."

REBUTTAL TO THE OBJECTIONS OF DOCTORS CHRISTOPHER, KOCH AND OWEN

JEROME J. WEINER, M.D.

NEW YORK, N. Y.

THE QUESTIONS raised by Doctors Christopher, Koch and Owen are:

First, that avulsing of the nail is a traumatizing procedure, and it takes from five to seven weeks for a new nail to regenerate; that where the nail regenerates it is fissured and deformed. The illustrations in my original communication of Cases 1 and 3 show the nail in Case 1 to be primarily fissured (Fig. 5). In Case 3, however, it regenerated quite normally. The bone has also regenerated. Assuming the nail is fissured in some instances, is it not preferable to give a patient a fissured nail rather than a deformed, mutilated and desensitized finger? Most of my cases show an initial fissured nail which ultimately is replaced by a normal one.

Second, they contend that bone involvement often occurs following infection of the anterior closed space, but the patient will recover most rapidly, and certainly, if the soft tissues are drained adequately and the bone is left alone. That to amputate the tip of the phalanx exposes the haversian canals and bone cells to further involvement. Two cases operated upon, subsequent to the original article, had the tuft of the bone removed; the indication for its removal being necrosis of Sharpey's fibers which were closely attached to the periosteum. In both these cases, the healing period was shortened by at least four weeks. Two other cases also showed necrosis of Sharpey's fibers. However, the tip of the phalanx was not removed. Both these cases required a longer period of time to heal as compared with the two preceding ones.

Third, Doctor Koch feels that, in some cases, the abscess may be close to the tip of the finger. If the abscess is close to the tip of the finger, beware of a collar-button abscess. Case 3, of my original article, was just such a type of case—and the patient pricked that superficial abscess herself. The subsequent roentgenograms revealed what happened. I wish to state to Doctor Koch that I did not remove the tuft of the bone in this case. I treated it along the lines suggested by both him and Doctor Christopher, namely, incising the soft tissues without removing the bone. After a period of time, the necrotic connective tissue sloughed away and, later, the diseased bone sequestrated itself and the wound commenced healing. I feel that had I removed the tuft of bone in this case, together with the necrotic connective tissue, I would probably have arrested the process and thus shortened the healing period. No doubt, Doctors Koch and Christopher have seen many incisions made in the median line for what appeared to be a superficial abscess of the tip of the finger. How many of these cases developed osteomyelitis due to inadequate drainage? No instance of anterior space infection can be adequately drained unless Sharpey's fibers are completely divided. Neither the median nor the lateral hockey-stick incisions accomplish this. Invariably, a thick plug of necrotic connective tissue blocks drainage and the infection is forced into the bone cells and haversian canals. Necrosis of the bone ensues and only when the sequestrum is extruded, does healing take place. The "fish-mouth" incision, while it provides adequate drainage, gives results as may readily be demonstrated. An eighth patient demonstrated what occurs in cases where inadequate drainage is obtained, and probes are used to ascertain the presence of sequestra. Incisions in this case were made through the nail.

Fourth, Doctor Kanavel, in his book on hand infections, claims that there is nothing superior to the ordinary dressing, saturated with hot boric acid solution, to wall-off an acute process.

Doctor Owen received an erroneous impression when he read my article. The local infiltration of 1 per cent novocain was by the simple method of block anesthesia, a procedure which is generally endorsed. The site of injection is at least two inches from the infection. It was perhaps an oversight not to have mentioned this obvious step in technic in my original communication.

I agree with Doctor Owen that a general anesthetic is the anesthesia of choice; however, did it occur to Doctor Owen that the economic factor had to be reckoned with in a majority of my cases? To spend but one day in the hospital costs the patient a minimum of $35 and up ($15 for operating room, $10 for anesthesia, $5 for board, $5 for laboratory fee). I have employed local anesthesia in most of my cases.

I firmly believe that the incision I have employed has a great deal of merit, because all of the major objections are overcome and the end-results are good.

JEROME J. WEINER, M.D.,
331 East 17th St.
New York, N. Y.

MEMOIR

DOCTOR GATEWOOD

1887–1939

BY THE UNTIMELY DEATH of Doctor Gatewood, of Chicago, on May 22, 1939, the Middle West has lost one of the most prominent of its younger surgeons.



DOCTOR GATEWOOD

Doctor Gatewood was the eldest son of Annie L. Pierrot and Dr. Wesley Emmet Gatewood, and was born October 11, 1887, in the little town of Stockport, Ohio, where his father, a graduate of the Medical Schools of Dartmouth and Bellevue, had come to practice. His elementary school education was received in Nashville, Tennessee, the place to which the family had moved

because of his father's failing health, and he graduated from the High School in Nashville in 1903, entering the Ohio State University in the fall of that year. He received the degree of A.B. from that institution in 1907, and that of M.A. in 1910, his research problems for the Master's degree having been undertaken in the departments of physiology and anatomy.

He began his medical work at the Ohio State University during the years 1907–1910, and was graduated from Rush Medical College in Chicago in 1911. Following this, a year was spent in the Pathology Laboratory at Michael Reese Hospital, and he served his internship at the Presbyterian Hospital under Dr. A. D. Bevan, where he continued as resident and associate in Doctor Bevan's service for several years.

Like all members of the surgical staff of the Presbyterian Hospital, Doctor Gatewood came up through the ranks as a teacher in surgery in Rush Medical College. Starting as an assistant in 1914, he held a Fellowship in 1918, was an instructor of surgery in 1919, an assistant clinical professor in 1923, an associate professor in 1929, and clinical professor of surgery in 1937, which position he held until the time of his death. Doctor Gatewood was always a student of surgery and throughout his surgical career was engaged in some type of experimental work.

His literary contributions cover a wide field, but he was particularly interested in that part of abdominal surgery having to do with the stomach and duodenum. As a teacher, he probably had no superior on the Rush Faculty, and it is a question whether anyone else in that group enjoyed an equal amount of respect and admiration on the part of the Rush medical students.

Recognition of Doctor Gatewood's caliber as a surgeon came early and continued through the years. Besides his membership in the American Medical Association, and the state and local medical societies, he enjoyed the distinction of belonging to the Chicago Surgical Society, the Western Surgical Association, the American College of Surgeons, and the American Surgical Association. He was among the Founders' Group of the American Board of Surgery.

Doctor Gatewood is survived by his wife, Esther Harper, to whom he was married in 1923, his son Emmet, and his daughters Helen and Mary Jean. His residence at the time of his death was in Highland Park, Illinois, where, among his civic interests was a membership on the School Board, in which work he took a very active part.

We, his colleagues, who have grown up with him since our intern days and have worked with him at Presbyterian Hospital, at Rush Medical College, and at the Cook County Hospital recognized him to be not only a most capable surgeon and a great teacher but a man of the highest quality. His sincerity of purpose, honesty, and modesty won for him not only the admiration of all those with whom he came in daily contact but the love of those who knew him best. In his sudden passing, at the age of 52, we feel an irreparable loss.

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CONDENSED REPORT

The Medical and Surgical Supply Committee was formed and is functioning under a Department of State permit, No. 357, dated August 7, 1940.

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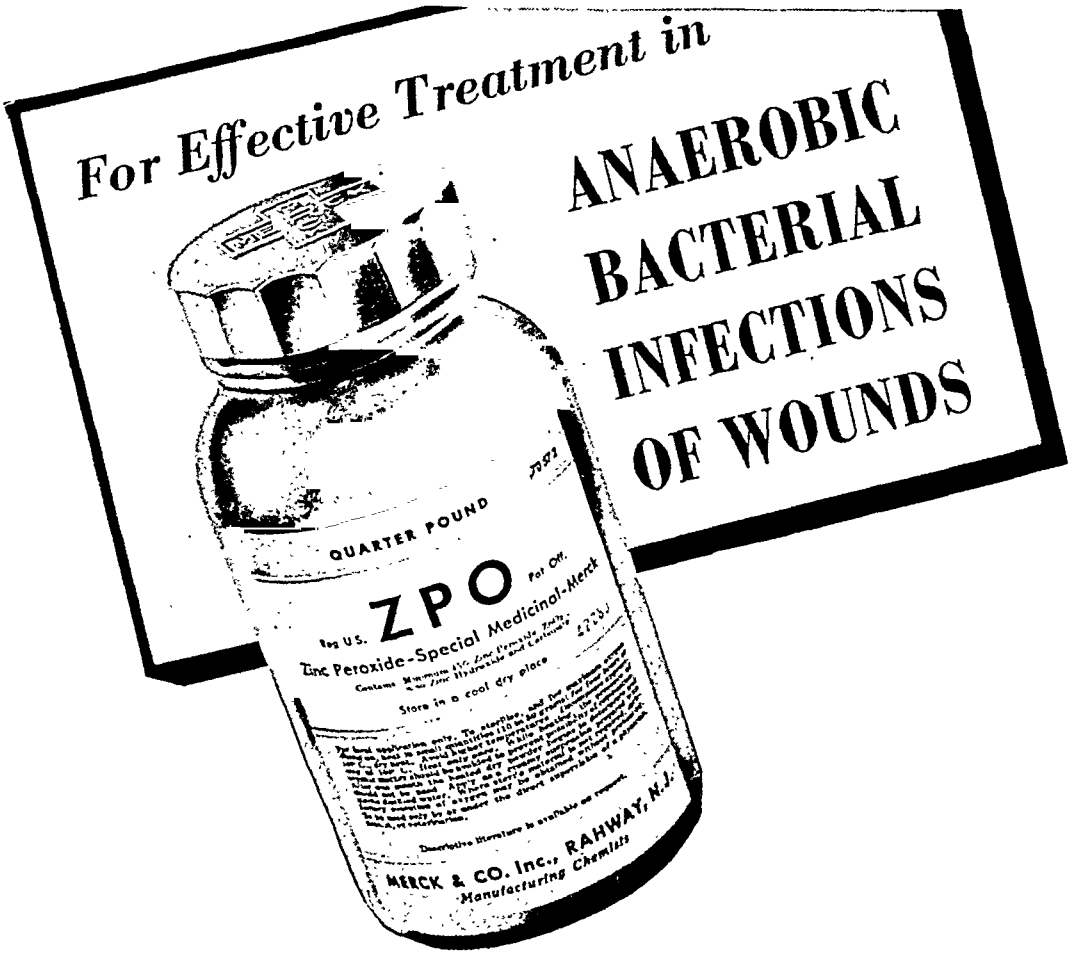
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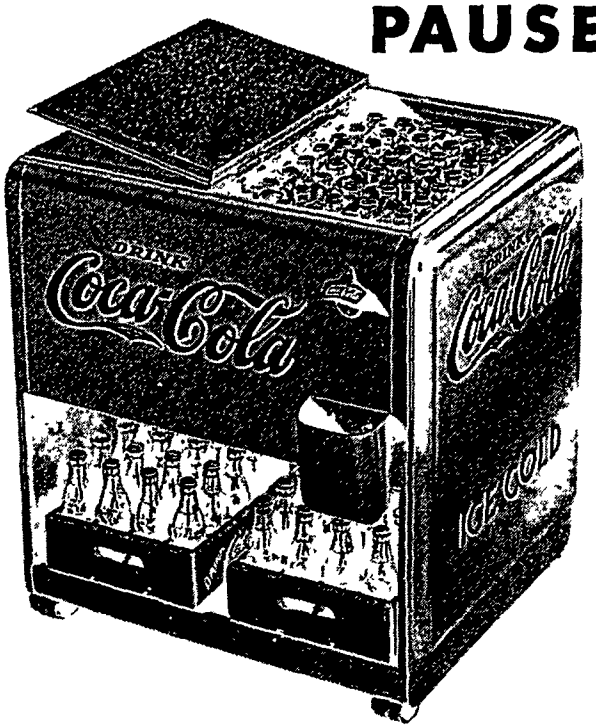
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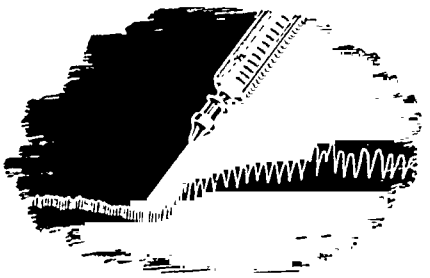
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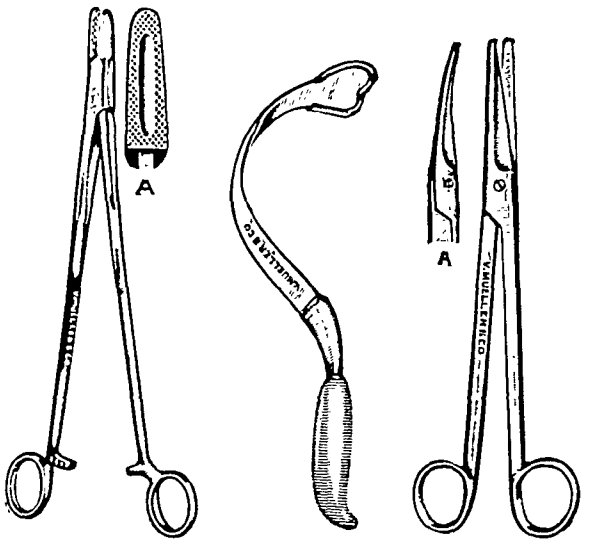
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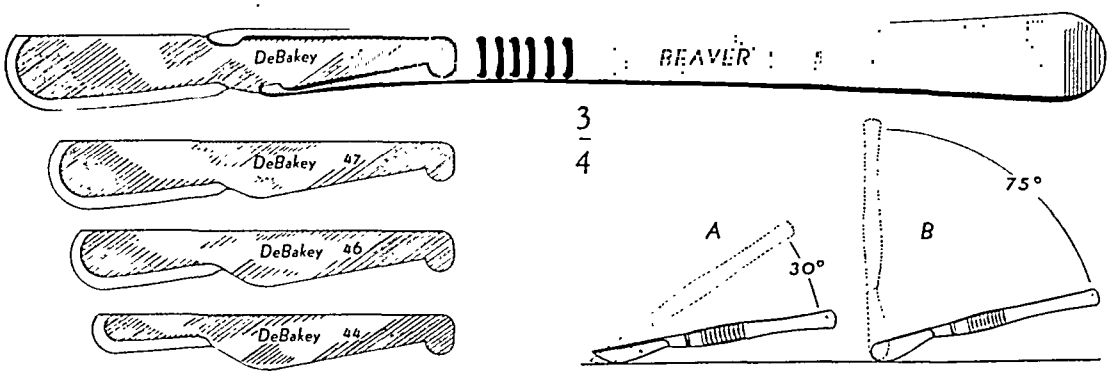
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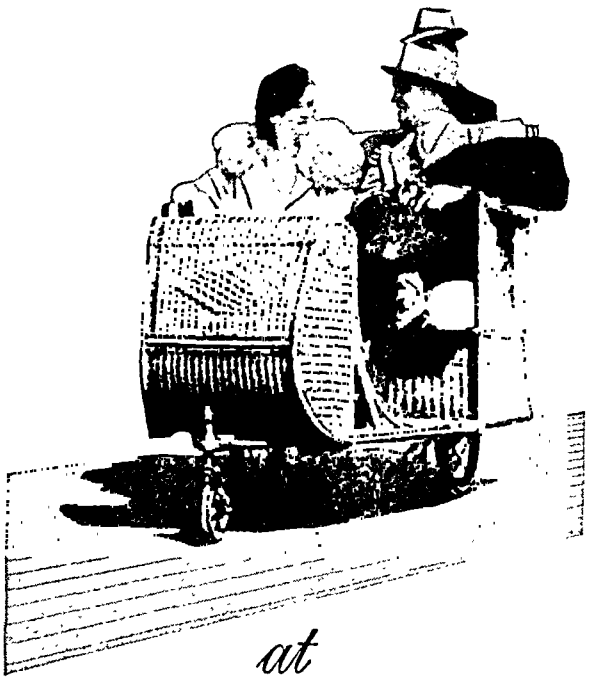
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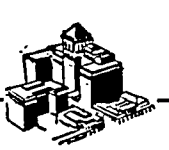
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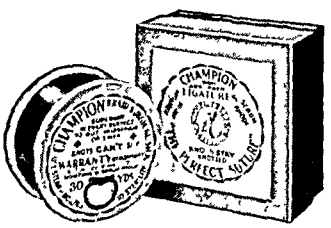
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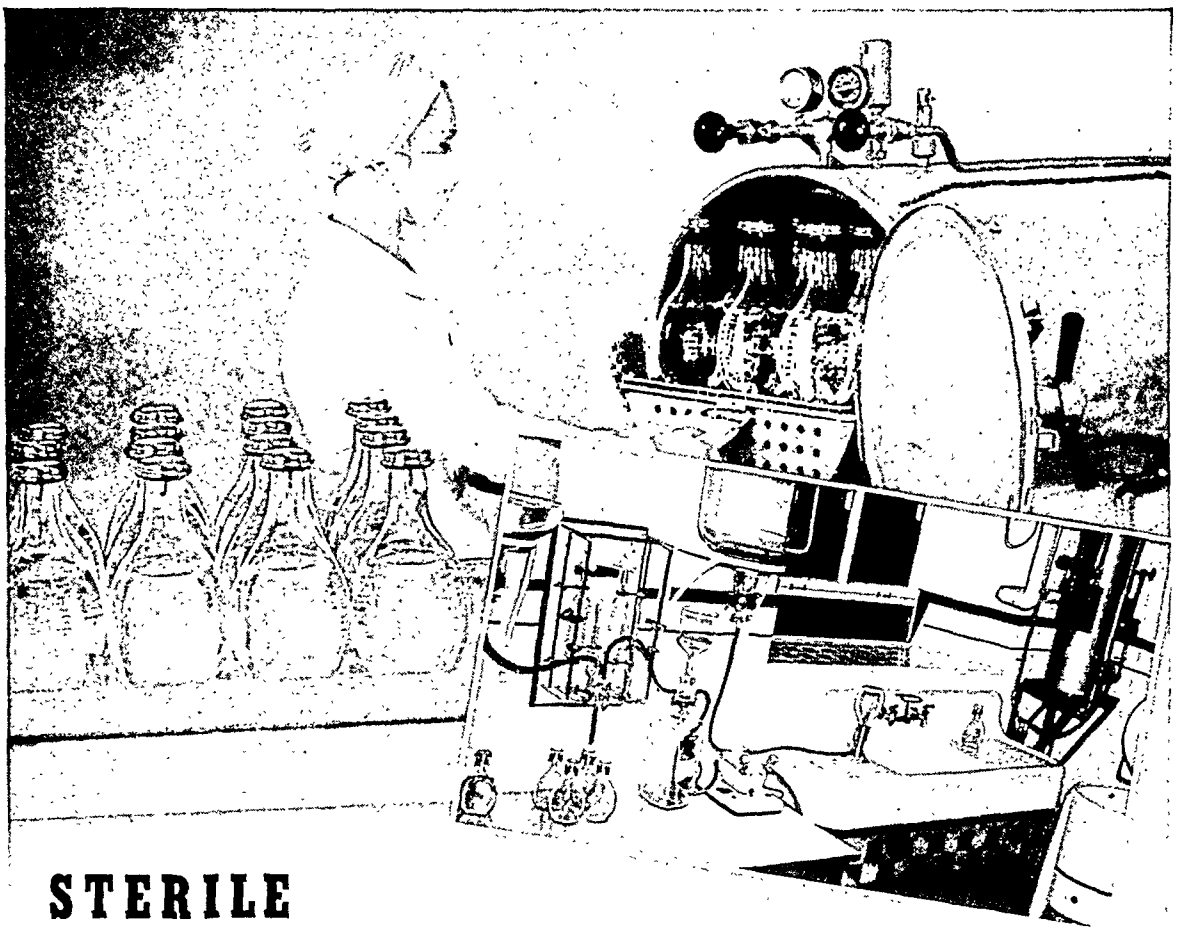
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CONTENTS

Vol. 113 FEBRUARY, 1941 No. 2

FRONTAL LOBECTOMY IN THE TREATMENT OF BRAIN TUMORS..... Byron Stookey, M.D.
John Scarff, M.D.
Michael Teitelbaum, M.D.

SUBDURAL HEMATOMA Guy H. Laudig, M.D.
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THE SURGICAL TREATMENT, BY DRAINAGE, OF SUBACUTE AND CHRONIC PUTRID ABSCESS OF THE LUNG Harold Neuhof, M.D.
Arthur S. W. Touroff, M.D.
Arthur H. Aufses, M.D.
New York, N. Y.

OBLITERATION OF THE PLEURAL SPACE FOLLOWING PNEUMONECTOMY.. F. J. Phillips, M.D.
W. E. Adams, M.D.
Chicago, Ill. 22

RUSSELL TRACTION IN THE TREATMENT OF FRACTURES OF THE FEMUR..... Kenneth M. Lewis, M.D.
New York, N. Y. 226

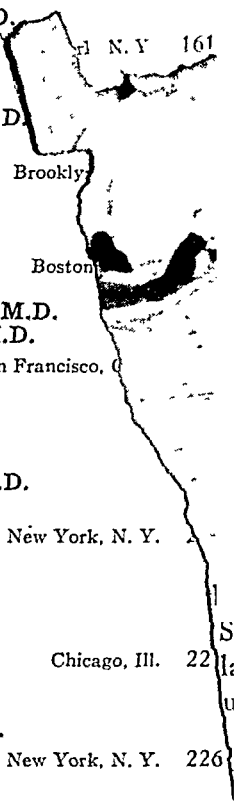
TOTAL THYROIDECTOMY FOR HEART DISEASE.. Elliott C. Cutler, M.D.
Stanley O. Hoerr, M.D.
Boston, Mass. 245

ONIC GASTRIC ULCER, IN CHILDHOOD, REATED SURGICALLY..... George B. Logan, M.D.
Waltman Walters, M.D.
Rochester, Minn. 260

FOR OF THE FEMORAL HERNIAL SAC .. H. J. McCorkle, M.D.
H. Glenn Bell, M.D.
San Francisco, Calif. 264

RCINOMA OF THE EXTREMITIES RENCE TO LYMPH NODE IN- Grantley W. Taylor, M.D.
Ira T. Nathanson, M.D.
Darrel T. Shaw, M.D.
Boston, Mass. 268

(*Contents continued on page 4*)



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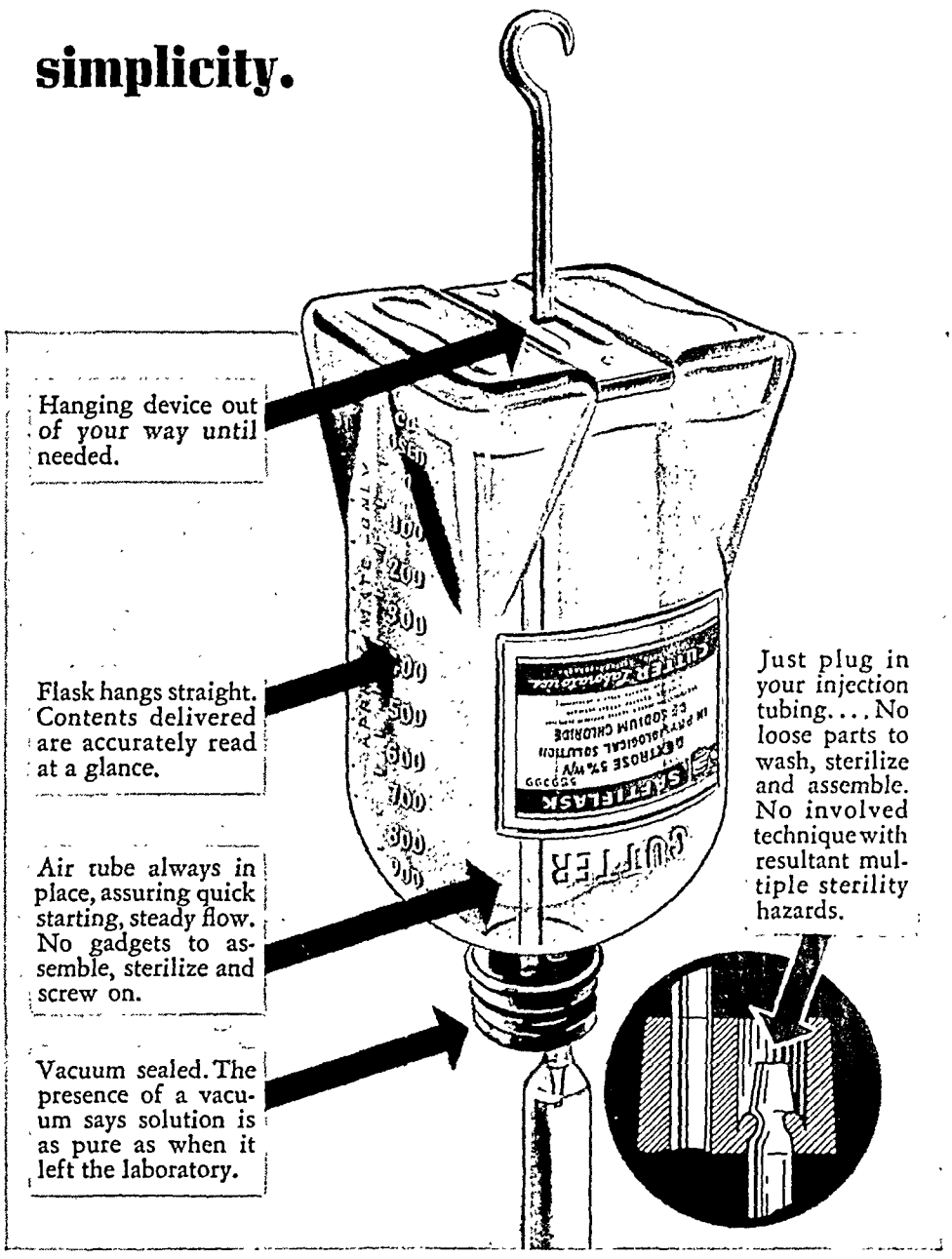


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HYPOPROTHROMBINEMIA: EFFECT OF PERORAL AND PARENTERAL ADMINISTRATION OF A SYNTHETIC VITAMIN K SUBSTITUTE (2-METHYL-1, 4-NAPHTHOQUINONE)..... L. M. Tocantins, M.D.
H. W. Jones, M.D.
Philadelphia, Pa. 276

THE LOCAL USE OF SULFANILAMIDE, SULFAPYRIDINE AND SULFAMETHYLTHIAZOL..... J. Albert Key, M.D.
Charles J. Frankel, M.D.
St. Louis, Mo. 284

DEGENERATION AND RECOVERY OF AUTONOMIC NEURONS FOLLOWING ALCOHOLIC BLOCK... Robert L. Merrick, M.D.
St. Louis, Mo. 298

BRIEF COMMUNICATIONS AND CASE REPORTS

ANGIOMA OF THE SKULL..... Walter D. Abbott, M.D.
Des Moines, Ia. 306

RESULTS OF SILK TECHNIC IN OPERATIONS FOR HERNIA..... Roland L. Maier, M.D.
New York, N. Y. 312

MEMOIR

HOMER GAGE..... David Cheever, M.D.
Boston, Mass. 315

SECTIONAL MEETINGS OF THE AMERICAN COLLEGE OF SURGEONS..... 318

BOOK REVIEWS

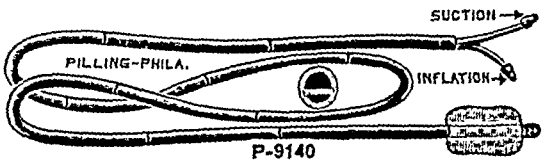
ORTHOPEDIC OPERATION..... Walter Estell Lee, M.D. 318

CANCER—A MANUAL FOR PRACTITIONERS..... Walter Estell Lee, M.D. 319

BOOKS RECEIVED..... 320

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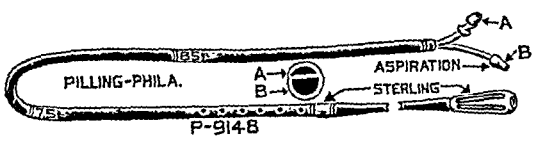
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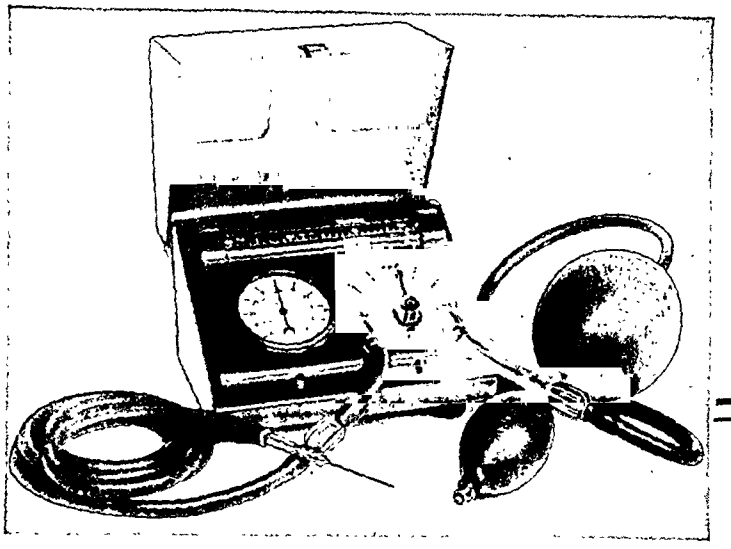


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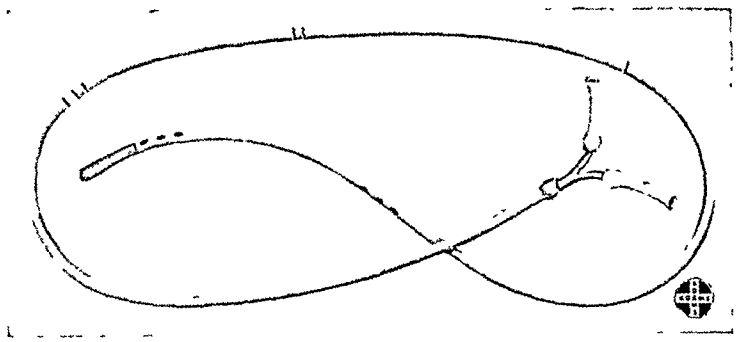
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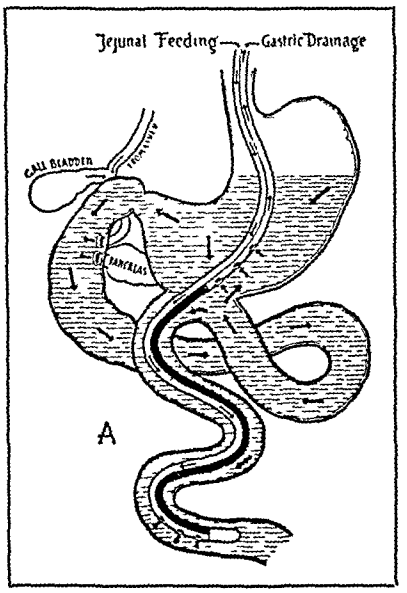
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*Described by Moses Einhorn, M. D., in Surg. Gyn. & Obst., January 1941.

INDEX TO ADVERTISERS

	Page
SURGICAL SUPPLIES	
American Cystoscope Makers, Inc.	5
Bard-Parker Company, Inc.	11
Rudolph Beaver	21
Clay-Adams	6
Cutter Laboratories	3
V. Mueller & Co.	14
George P. Pilling & Son Co.	4, 19
LIGATURES	
Davis & Geck, Inc.	Insert, 8-9, 16
C. De Witt Lukens Co.	16
Johnson & Johnson	15
PHARMACEUTICAL SUPPLIES	
Anglo-French Drug Co., Inc.	Inside Front Cover
Armour & Company	17
Ciba Pharmaceutical Products, Inc.	Back Cover
Duke Laboratories, Inc.	12
Hoffmann-La Roche, Inc.	7
Parke, Davis & Company	9
Purdue Frederick Company	21
Schering Corporation	Inside Back Cover
Wander Co., The	13
William R. Warner & Co., Inc.	10
Winthrop Chemical Co., Inc.	8
PUBLISHERS	
Journal of Bone and Joint Surgery	22
Lea & Febiger	20
J. B. Lippincott Company	12, 19, 23, 24
C. V. Mosby Company	18
HOTEL	
Chalfonte-Haddon Hall	12
SCHOOL	
Chicago Post-Graduate School of Surgery	14



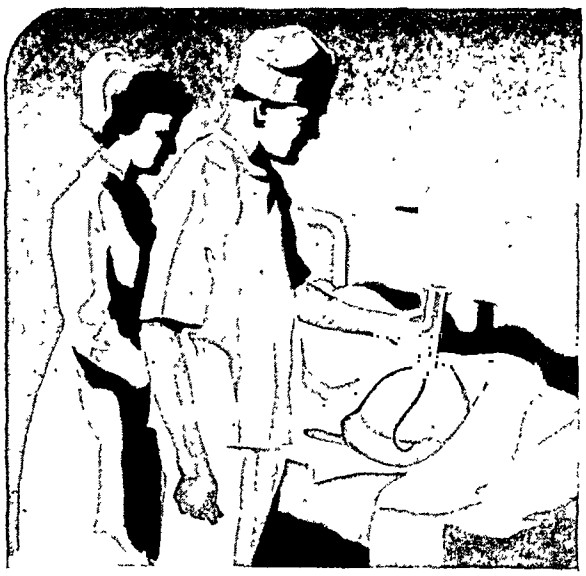
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The Rationale of Suture Use

BRIEF DISCUSSIONS BASED ON REPORTS OF CURRENT RESEARCH AND CLINICAL OBSERVATION

Bacterial Contamination at the Operating Table

METHODS of preserving the sterility of sutures during preliminary preparation and handling in the operating room are now quite generally understood, but the many opportunities for their contamination *within the operating field itself* are still too frequently overlooked.

The so-called "clean wound" is seldom completely sterile. Bacteria enter it from the air, from the respiratory tracts of the operating personnel and from the skin of the patient. Sutures may, therefore, and often do, become contaminated through repeated contact with the blood and serum of the wound as well as through contact with exposed skin.

Allowing the uninserted portion of continuous sutures to fall unnecessarily on exposed tissues, or tying interrupted sutures from long lengths of material result in progressive contamination of the strand. Ligating from a spool also leads to soiling of the material through the excessive handling it receives under this technic.

The use of individual sutures and individual ligatures provides the best assurance that the material will reach its final location in the tissues in a relatively sterile state. In any case care exercised in keeping the strand clear of the wound and its environment will be well rewarded. Likewise the sutures should be kept clear of instruments and gauze returning from the wound and the salt solution used to cleanse these instruments or to moisten the gauze.

In wounds made to drain infected foci every effort should be made to prevent contamination of the wound and the sutures with pus. Otherwise the sutures inoculate bacteria into locations in the tissues where these organisms would never have been carried by seepage. If, however, the wound edges are adequately protected with laparotomy sponges, the pus removed from the focus by suction and not allowed to flow over the wound, and if the wound is irrigated with saline to remove superficial bacteria before closure is attempted, then the sutures will not become contaminated or at least contamination will be minimal.

Bibliography or answers to specific questions on this subject will be sent on request. DAVIS & GECK, INC., *Brooklyn, N. Y.*

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WITH SWAGED-ON ATRAUMATIC* NEEDLES

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1305	½-circle needle A-5	28″	4.20

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1342	Two straight needles A-1	36″	4.20
1343	⅜-circle needle A-3	28″	4.20
1344	Small ½-circle needle A-4	28″	4.20
1345	½-circle needle A-5	28″	4.20

Sizes: 00, 0, 1

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(Medium chromic—type C)

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50344	Size 5-0, needle A-4	28″	4.20
40341	Size 4-0, needle A-2	28″	3.60
40344	Size 4-0, needle A-4	28″	4.20

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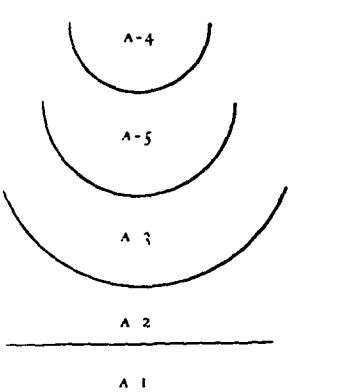
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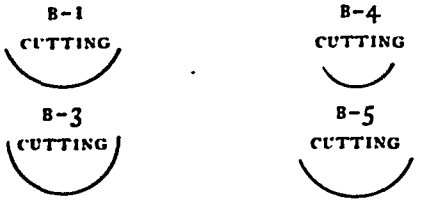
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NO.	MATERIAL AND NEEDLE	LENGTH *in excess of*	SIZES
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1663	Plain—type A catgut, B-5	18″	4-0
1665	Black silk, B-1	18″	6-0, 4-0
1667	Plain—type A catgut, B-4	18″	3-0
1669	Mild chromic—type B, B-5	18″	4-0, 3-0
1669D	Mild chromic-type B, B-5	9″	4-0, 3-0

Double-armed

1662	Black silk, B-3	12″	6-0
1664	Black silk, B-1	12″	6-0, 4-0
1666	Plain—type A catgut, B-4	12″	3-0
1668	Mild chromic-type B, B-5	12″	4-0, 3-0
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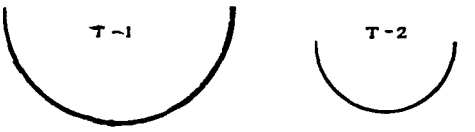
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1635	Plain—type A catgut, non-boilable, T-1	28″	0

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1652	Kal-dermic, B-5	18″	4-0, 00
1653	Black silkworm gut, B-1	14″	4-0
1655	Kal-dermic, B-2	18″	4-0
1658	Black silk, B-2	18″	4-0

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IN ADDITION to the sutures described on these pages, the D&G line includes over a hundred suture and needle combinations specially designed for specific procedures. These are in addition to a complete range of non-needled sutures embracing catgut, kangaroo tendons and bands, Anacap silk, Kal-dermic skin and tension sutures, etc. Information on all D&G products is available from your dealer or, by mail, from us.

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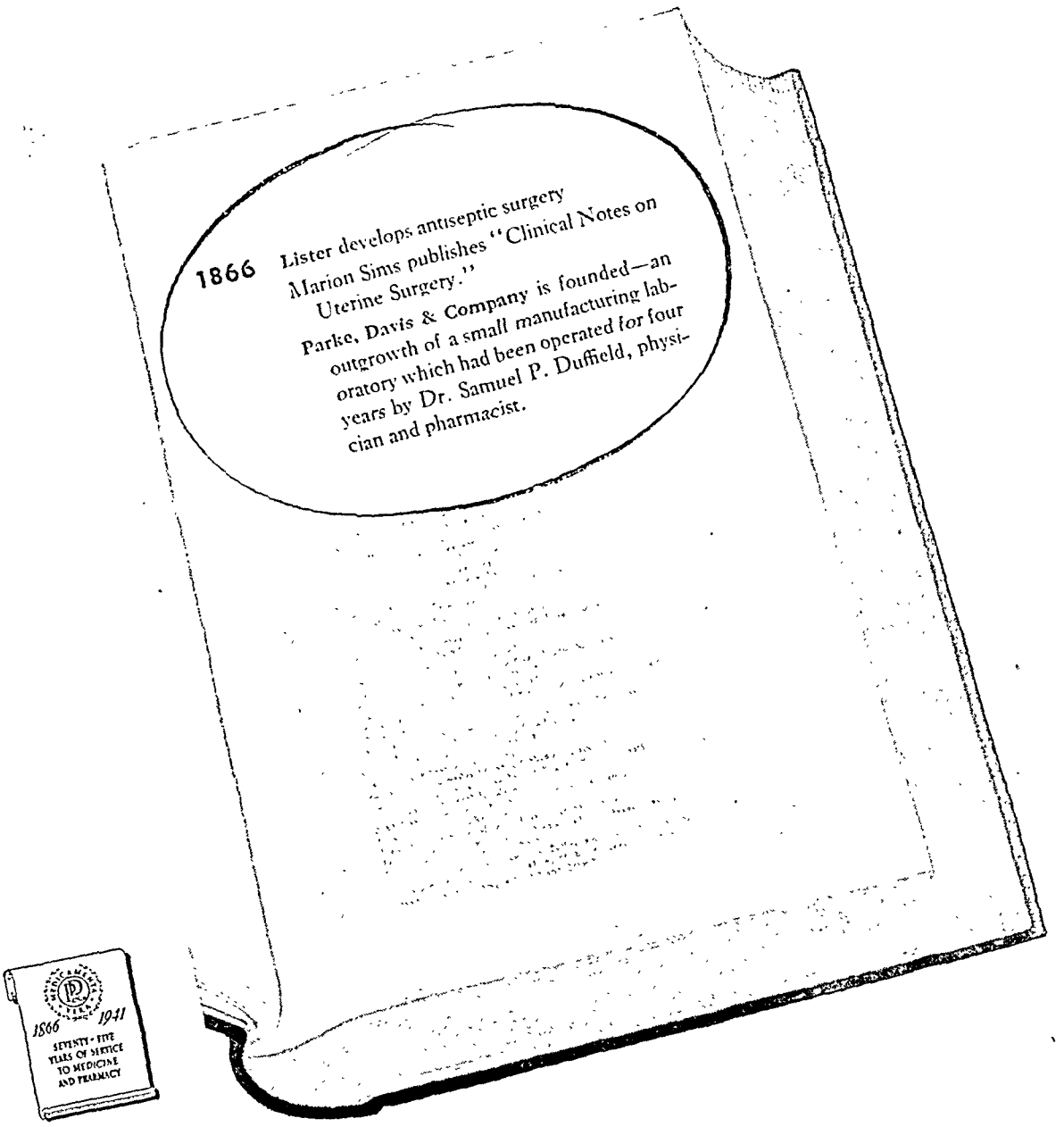
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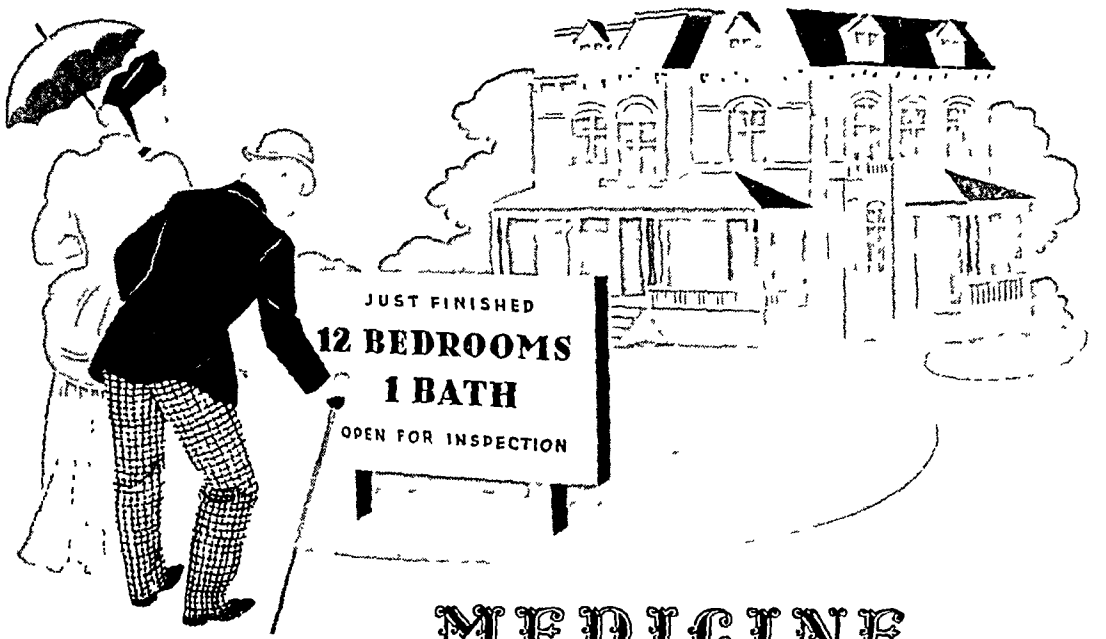
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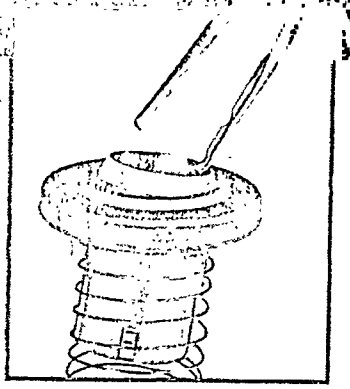
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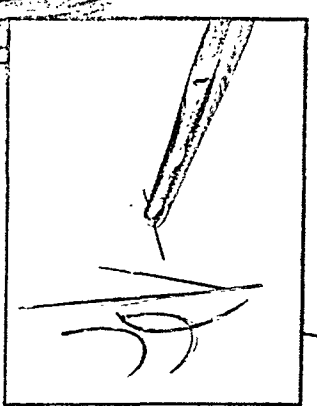
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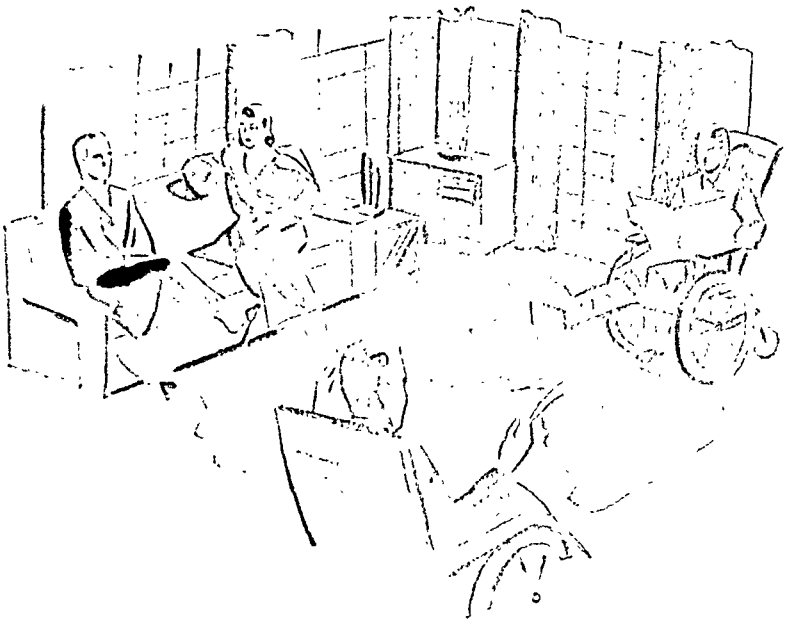


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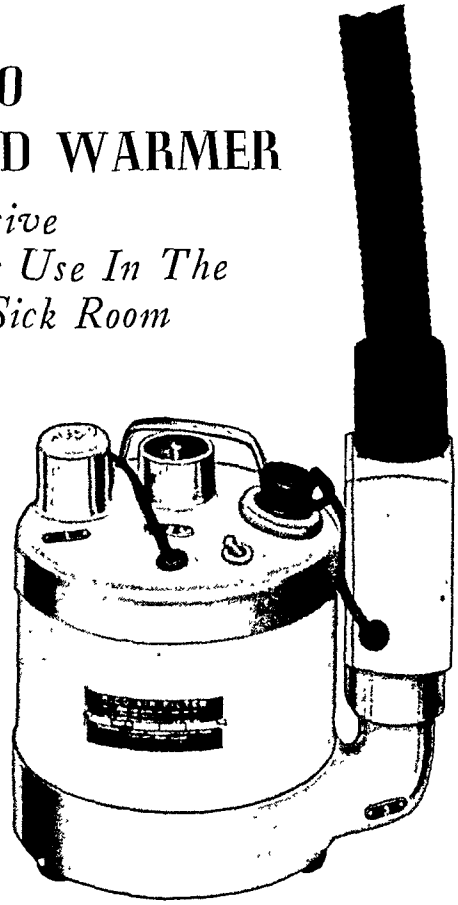
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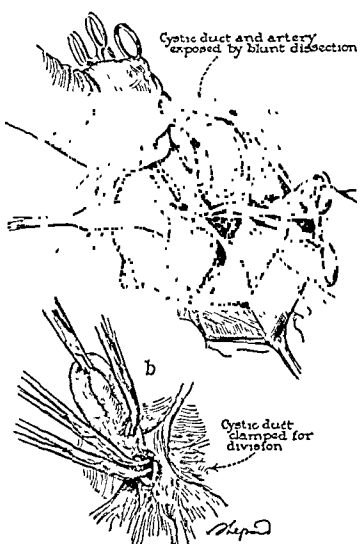


Fig. 232. Cholecystectomy. (a) The cystic duct and cystic artery are being dissected free from the tissues of the duodenal-hepatic ligament with the tip of a Moynihan forceps; (b) the cystic duct is doubly clamped with Moynihan forceps. (Illustration reduced from original.)

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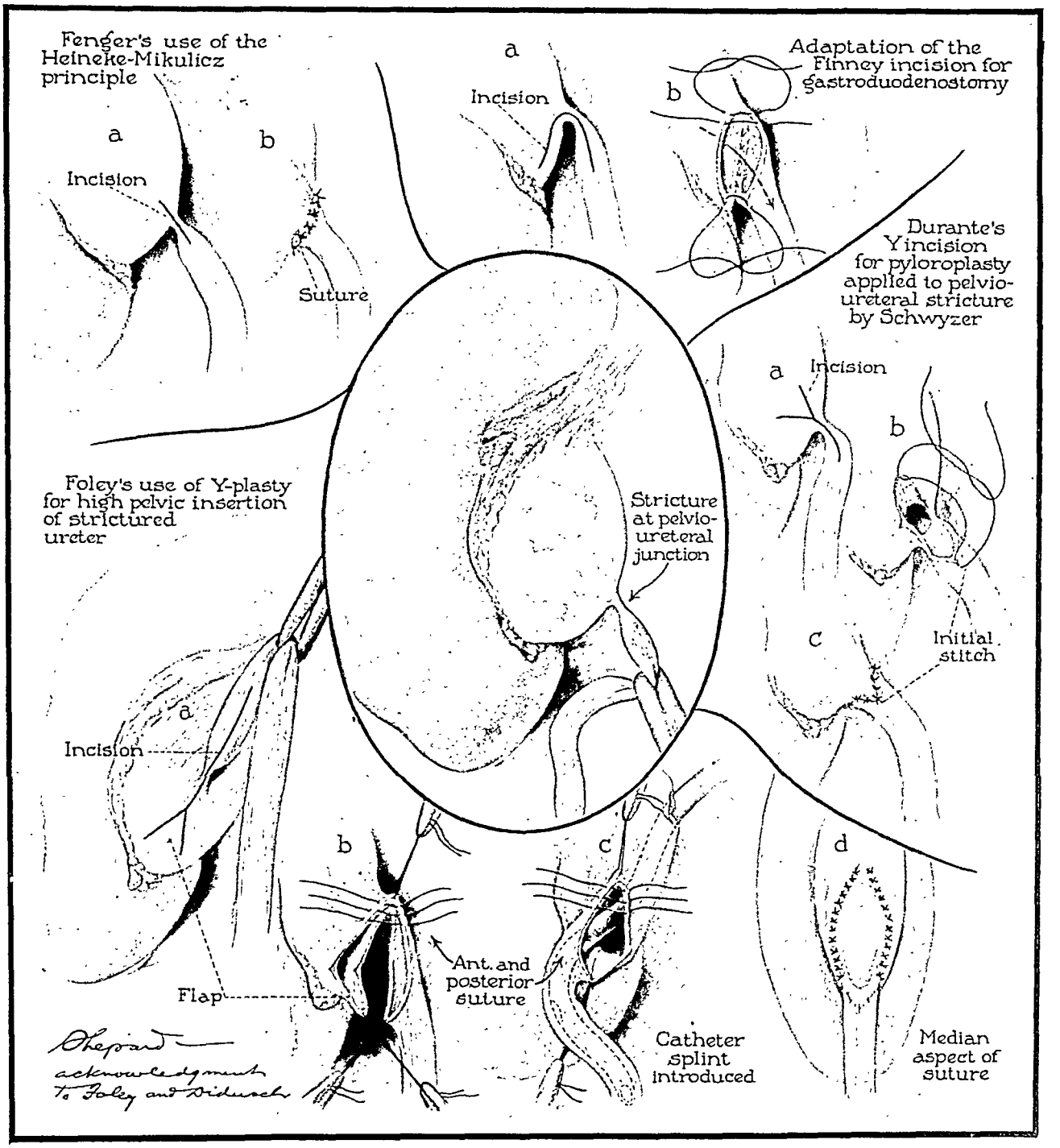
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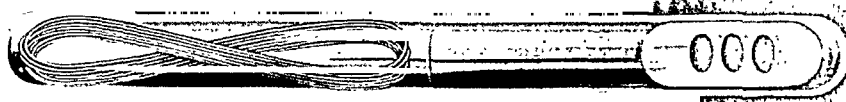
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FRONTAL LOBECTOMY IN THE TREATMENT OF BRAIN TUMORS*

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FRONTAL LOBECTOMY in the radical treatment of brain tumors is of twofold interest. To the neurophysiologist it furnishes an approach to the study of frontal lobe function, supplementing clinical observation and experimental investigation. To the surgeon it is of primary interest from the standpoint of the surgical removal of brain tumors. It is from the latter point of view that the present report is made. The surgical aspects, however, here as elsewhere, are inseparably bound up with the consideration of function—its disturbance by the lesion and the possibility of its restoration by adequate therapy.

Starr,[16] as early as 1884, reviewing 23 cases of frontal lobe lesions, found lack of self-control to be the most common feature, with inability to fix the attention, to follow a continuous train of thought, or carry on intellectual processes. To this loss of self-control he attributed the associated changes in behavior, since the mind exercises a constant inhibitory influence upon all action, physical and mental, from the restraint of the lower reflexes to the higher control of emotional impulses and their manifestation in speech and expression. The exercise of control implies a recognition of the import of an act in connection with other acts. In a word, it involves judgment and reason. By inhibiting all but one set of impulses, it makes it possible to fix the attention upon a subject and to hold it there. Starr regarded it as probable that the processes involved in judgment and reason have for their physical basis the frontal lobes. Destructive lesions of these lobes, therefore, would manifest themselves by errors of judgment and reason of a striking character.

Starr's observations were borne out by those of Mohr[13] on a case of pituitary tumor causing compression of the frontal lobes, manifested by childishness and urinary and fecal incontinence. Another early example was the famous "crowbar case" of Harlow[9] (1868), in which the patient suffered severe damage to the dominant frontal lobe. From a hard-working foreman,

* Read before the New York Surgical Society, February 28, 1940. Submitted for publication January 26, 1940.

commanding the respect of both his employer and workmen, he became fitful, impatient, capricious and vacillating, and a child in intellectual capacity.

Since these early reports a vast literature on frontal lobe tumors has accumulated. The more striking features, as recorded by others and as observed in our cases, are disturbances in memory and orientation, changes in personality, inability to synthesize thought processes into more complex reasoning, and *"witzelsucht."* Less common are the so-called frontal lobe stupor and vesical incontinence. Holmes,[10] in 1931, described three types of personality change: A type characterized by apathy and indifference; another by depression, automaticity, and incontinence; and a third by restlessness, exuberance, euphoria and *"witzelsucht."* All three types were observed in our series. The individual personality probably determines in some measure the degree at which these various types are unfolded with the dissolution accompanying the disease process.

The frontal lobe, defined as the area anterior to the central sulcus, includes four subdivisions: the motor area, Area 4 of Brodman;[2] the premotor area, Area 6 of Campbell;[3] the speech area; and the frontal area, the region anterior to Brodman and Campbell's Area 6. Area 6 has been further subdivided by Vogt[17] into Area 6 $a\alpha$ and Area $a\beta$, the former lying, in man, within the precentral convolution.

The term lobectomy is, we believe, misleading. It has been used, however, by Dandy,[4] Spurling,[15] Penfield and Evans,[14] German and Fox[8] and others, to designate removal of the frontal area exclusive of the speech, premotor, and motor areas, and is often spoken of as the prefrontal area. The line of incision in our series has, as a rule, included Areas 8, 9, 10, 11, 32, 34, 46, and 47, and occasionally 6 $a\beta$ but never 6 $a\alpha$ or 4.

McCaw,[12] in 1919, reported a case of resection of the right temporosphenoidal lobe, without, however, a detailed study of the after-effects. Dandy, in 1933, stated that the entire right or left frontal lobe could be removed "without any observable mental or other after-effect."

Critical studies of the after-effects of unilateral frontal lobectomy have been published by Penfield and Evans, German and Fox,[6, 8] and Spurling. Penfield and Evans, in 1932, reported four cases. In one of these the operation was undertaken for removal of a calcified oligodendroglioma, in the other three for posttraumatic convulsive seizures. German and Fox,[8] in 1932, resorted to lobectomy in two cases of spongioblastoma, and Spurling, in 1934, removed the right frontal area for a subfrontal meningioma. Thus, of the seven lobectomies in which a critical analysis has been made, three were performed for tumors of the glioma series, three for cerebral scars, and one for a subfrontal tumor.

The case material forming the basis of this discussion consists of 11 gliomata of the frontal lobe. Cases in which the operation was performed for traumatic epilepsy and a small series of meningiomata will not be considered here.

This last group presents certain practical problems which have not yet been satisfactorily solved, at least in our hands. Fatalities have occurred in this

latter group which we believe can be avoided in the future as we have further opportunity to master the problems involved. The operation for these tumors consists of two major procedures: The removal of the frontal lobe, which in itself is an operation of considerable magnitude; and, following this, the difficult attack upon the large meningioma lying in close proximity to the great vessels at the base and in part surrounding the vessels forming the circle of Willis.

Of the 11 gliomata, three were in the glioblastoma group, and nine in the astrocytoma series. All of the patients survived the operation and, with the exception of the three who had extensive glioblastomata, all are alive and carrying on useful lives. In six of the nine patients with astrocytoma, we were able to excise the tumor completely and, we hope, effect a cure. In the remaining three the tumor extended beyond the line of excision, either dorsally into the motor area or across the midline into the corpus callosum. In the following discussion we shall consider chiefly those cases in which the lesion was completely excised, though the three patients in whom tumors still remain form an interesting series. They have shown some improvement and have made fair social adjustments.

It has seemed curious that though unilateral frontal lobe tumors, with but little evidence of generalized increased intracranial pressure, give rise to symptoms permitting their diagnosis, yet the most thorough and painstaking clinical studies are essential to detect absence of the frontal lobe after its removal. A far more searching examination is necessary to discover that frontal lobectomy has been performed than to determine the presence of a frontal lobe tumor.

The frontal lobes are primarily association centers receiving impulses from all other parts of the brain. They are intimately connected, so that the proper function of each is dependent upon impulses of a certain order and frequency reaching it through the association paths between the two.

According to Hughlings Jackson[11] the muscles of each extremity have bilateral representation in the dominant hemisphere and also in the hemisphere of the opposite side. This he held to be true not only for muscles acting separately but more especially for muscles which function synchronously, as the facial muscles, those of the diaphragm, and others. Jackson states that: "My supposition is that the limbs of the two sides are very unequally represented in each half of the brain while the bilaterally acting muscles are very nearly equally represented in each half." If this be true for muscles, how much more likely is it that syntheses which constitute personality, thought, memory, *etc.*, must be the combined product of both frontal lobes, and not of one or the other alone, regardless of the handedness of the individual. There would seem to be little doubt that personality and the association and synthesis of mental processes are bilaterally represented and that their expression is the simultaneous product of both frontal lobes.

The presence of a tumor in either lobe distorts the frequency and type of wave discharge, interfering not only with function on the diseased side but

also on the opposite side. Frontal lobe symptomatology is thus expressive of disturbance of both lobes and not of one alone. The smooth performance of either lobe is dependent upon the smooth performance of the two together. If distorted impulses from one lobe reach the opposite side, disturbance of function becomes evident. If, however, the disturbing lobe is removed, whether this be dominant or nondominant, as has been done in the cases recorded here, the remaining lobe is able to carry on so well that the loss is hardly to be detected.

The "static," so to speak, produced in one frontal lobe interferes with the function of the opposite lobe as well as with its own. Normally, both frontal lobes function together harmoniously, or one may compare the function of the frontal lobes to a well synchronized and harmoniously playing orchestra. If the first violins play out of tune, or play their own tune, the music produced by the orchestra can hardly be called music. If, however, the first violins are removed the orchestra may well go on playing in harmony as a united symphony. By removal of the diseased lobe the irritative lesion is eliminated and the patient is left with an intact frontal lobe which is capable of carrying on now that it is no longer disturbed by irregular and purposeless emanations from the opposite side. This applies not only to removal of the nondominant, but also the dominant frontal area. In either instance the remaining lobe is able to carry on so well that the absence of the other is difficult to detect. This concept of frontal lobe function, considered in its broadest sense, is borne out by the cases recorded here.

A critical search for frontal lobe signs following lobectomy has yielded little of importance. The grasping and groping reflex described by Adie and Critchley[1] was not present in a single instance. It will be recalled that in their review of the cases in the literature, these authors concluded that the lesion responsible for this reflex was situated in the posterior portions of the superior and middle frontal convolutions. Their figures indicate approximately the Area 6 $\alpha\beta$. When the grasping reflex is present, it is taken to indicate a lesion in this region, but certainly large tumors of the frontal lobe may exist in which the reflex is not present. In those instances, furthermore, in our series in which this area was traversed by the line of excision, the reflex did not occur. This was also the experience of Foërster, who reported excisions of this area without detectable signs. His explanation is in accord with Hughlings Jackson's suggestion that if the movements produced by one area are represented in another area, in approximately the same combination and order, they need not be lost with removal of the area in which they are produced.

Foërster[5] found that the movements produced by Area 6 $\alpha\beta$ were similar to those elicited by Area 5. The inference is that at least part of the function of Area 6 $\alpha\beta$ is taken over by Area 5. This being the case, one would expect to find the grasping and groping reflex or some modification of it, in lesions of the latter area.

It is also noteworthy that in some cases reviewed by Adie and Critchley

the lesions involved the basal ganglia. The area outlined by those writers has been shown by Fulton and his coworkers[7] to be essentially the region which they have demonstrated as the cortical representation of the extrapyramidal motor system.

The study of the patients in this series has consisted of a complete neurologic examination and a social investigation, with observations on admission to the hospital and a follow-up by social workers who visited the patients at regular intervals. The early development, scholastic background, social and family life have been gone into thoroughly and information from other sources has been obtained. Psychiatric interviews were conducted by Doctor Teitelbaum, whenever possible, prior to operation and in every case following operation. Complete psychometric tests were made by the Psychology Department, Miss Tallman doing all the testing. These included vocabulary tests, performance tests, and personality tests, such as the Rohrschach and Jung association tests.

The conclusion reached is that the patients in whom the lesion was completely excised, whether from the dominant or nondominant hemisphere, were intact, both as regards the past and the present life. They appeared genuine in their responses and on nonpsychiatric investigation it would be exceedingly difficult to tell that there had been anything wrong with them. In several instances, indeed, they functioned on a better level than before operation. They showed little impairment of general intelligence, they planned and executed household duties competently, were able to sew, market, cook, plan for guests, *etc.* There was no slowing-up of the common everyday performances. In some instances a lack of distractability was notable. There was no hesitation in putting into effect a decision, but the decision once made was maintained until its execution was completed.

There was a complete return of the former emotional tone. The sexual life of five or six patient returned to its former status. In one, however, frigidity developed and she came to look upon the sexual act solely as a duty.

Some of the patients showed distinct evidence of a new ability to learn; they acquired new interests, became socially more adaptable, and calmer emotionally. None showed any loss of inhibition, and in not one was there any disturbance of spatial orientation.

However, in the group in which the tumor extended beyond the line of incision, the results were quite different. These patients were shallow emotionally, listless, indifferent, and lacking in initiative. One, though she was able to care for herself, sat about the house day after day, refusing to go out, and evincing no interest in outside life. Another, while markedly improved in intellectual functions, showed a failure in social adjustment and a lack of inhibition, wetting herself, for example, and attributing this to the poisoning of her food by others. Three of the patients in this group, however, were able to care for their homes and children, and to adjust themselves mentally so long as no complex situation arose. They were, for example, able

to talk intelligently with one or two people, but were unable to carry on a conversation with a number of people or in a crowd.

This series of cases thus offers confirmatory evidence of the theory suggested earlier in this communication. Where the lesion was completely removed, the intact lobe freed from the distorted impulses due to disease of the opposite side proved able to carry on for all practical purposes as efficiently as before. When, on the other hand, only partial removal was effected, though some improvement took place an irritant still remained, interfering with the smooth synchronous functioning of the two lobes.

BIBLIOGRAPHY

[1] Adie, W. J., and Critchley, Macdonald: Forced Grasping and Groping. Brain, 50, 142, 1927.

[2] Brodmann: Beiträge zur histologischen lokalisation des grosshirnrinde, etc. Jour. f. Psych. U. Neurol., 1906.

[3] Campbell, Alfred W.: Histological Studies on the Localization of Cerebral Function. Cambridge University Press, p. 360.

[4] Dandy, Walter E.: Physiological Studies Following Extirpation of the Right Cerebral Hemisphere in Man. Johns Hopkins Hosp. Bull., 53, 31, 1933.

[5] Foërster, Otto: The Motor Cortex in Man in the Light of Hughlings Jackson's Doctrine. Brain, 58, June, 1936.

[6] Fox, James C., and German, William J.: Observations Following Left (Dominant) Temporal Lobectomy. Arch. Neurol. and Psychiat., 33, 791, 1935.

[7] Fulton, J. F., and Jacobsen, C. F.: The Functions of the Frontal Lobes—A Comparative Study in Monkeys, Chimpanzees and Man. XVth International Congress, Advances in Modern Biology, 4, 13, Moscow: State Biological and Medical Press.

[8] German, William J., and Fox, James C.: Observations Following Unilateral Lobectomies. Assn. for Res. in Nerv. and Ment. Dis., Proc. 13, 378, 1932.

[9] Harlow, John N., of Woburn: Recovery from the Passage of an Iron Bar Through the Head. Massachusetts Med. Soc., 2, 329, 1867–1868.

[10] Holmes, Gordon: Mental Symptoms Associated with Cerebral Tumours. Proc. of Roy. Soc. of Med. (Sect. Neurol. and Sect. Psychiat.), 24, 65, 1931.

[11] Jackson, J. Hughlings: Croonian Lectures on "Evolution and Dissolution of the Nervous System." Brit. Med. Jour., 1, 591, March 29, 1884; 660, April 5, 1884.

[12] McCaw, J. F.: Gangrene of the Temporosphenoidal Lobe, Right Side, of Otitic Origin: Operation and Extensive Excision of the Lobe, with Recovery. Ann. Otol., Rhinol. and Laryngol., 28, 823, 1919.

[13] Mohr: Hypertrophie der Hypophysis cerebri und dadurch bedingter Druck auf die Hirngrundfläche, *etc.* Wchnschr. f.d. ges. Heilk. Berlin, 565.

[14] Penfield, Wilder, and Evans, Joseph: Functional Defects Produced by Cerebral Lobectomies. Assn. for Res. in Nerv. and Ment. Dis., 13, 352, 1932.

[15] Spurling, R. Glen: Notes upon the Functional Activity of the Prefrontal Lobes. Southern Med. Jour., 27, 4, January, 1934.

[16] Starr, M. Allen: Cortical Lesions of the Brain: A Collection and Analysis of the American Cases of Localized Cerebral Disease. Amer. Jour. Med. Sci., New Series, 87, 1, 366, January–April, 1884.

[17] Vogt, Cecile u. Oskar: Allegemeiners Ergebuisse unserer Hirnforschung Jour. Psychol. u. Neurol., 25, 279, 1919.

DISCUSSION.—DR. JOHN E. SCARFF (New York) said that as a result of the studies by Doctor Stookey, Doctor Teitelbaum and himself, it would appear possible to make certain generalizations regarding function—and the

functioning—of the frontal lobes: In the first place, it would appear that either one of the frontal lobes, singly, is capable of carrying on in a satisfactory manner the work normally done by the two frontal lobes working together, provided that the remaining frontal lobe does not have its function interfered with by any disease process. This interference with function might come from extensions of the tumor remaining outside the lines of excision of the lobe, either on the side of the lobectomy or by invasion of the opposite side by way of the corpus callosum.

The second generalization is that it was not possible to find any dominance existing in the frontal lobes. It is well known that dominance exists in the temporal and parietal lobes, and it has been generally assumed that this existed in the frontal lobes. Observations made in the present study did not confirm this general concept. If there was a clean removal of the left frontal lobe the patient did as well afterward as did the patient from whom the right frontal lobe had been removed. There were no exceptions to this rule in this series.

In the third place, a better idea of the mechanism by which the so-called "frontal lobe syndrome" is produced has been acquired. This syndrome is characterized by defects in intelligence and alterations in personality. It would seem that this "frontal lobe syndrome" is due not so much to *suppression* of frontal lobe function as to *distortion* of frontal lobe function, by some pathologic process. Doctor Stookey used the simile of an orchestra to illustrate this point, and indicated how one section of violin, playing out of key, would result in discord from the efforts of the entire orchestra; whereas, if the off-key violins were removed, the remaining portions of the orchestra would be able to produce pleasing music.

Doctor Scarff had hoped Doctor Stookey would find time to mention one patient who illustrated this last point very well, namely, that it is not the absence or suppression of function but the distortion of function that is responsible for the "frontal lobe syndrome." A woman, in her thirties, had for many years supported herself as a commercial artist, and was very successful. Then she became ill. When seen on the ward, she was quite sick and was confined to bed. She appeared alert and followed the examiner with her eyes and smiled. She had no true motor weakness but was completely helpless. Objects would be placed in her hands and she would not know what to do with them. A tray would be placed in front of her with luncheon on it, and eating utensils were there, but she could not figure out how to get the food to her mouth. Although she had power in her extremities she could not stand alone. In short, she was completely apraxic. Although there was no sign of generalized intracranial pressure, study showed that she had a left frontal lobe tumor. Following its removal she became practically a normal person within a very few weeks, and was soon able to draw quite quickly and accurately, and as well as before. It would seem as though "static" given off by the diseased left frontal lobe had caused interference with the smooth functioning of the normal right frontal lobe; and that after the removal of this "static" the right lobe carried the load quite satisfactorily.

The cases that have been shown were all gliomata. When the tumor was removed, as a matter of course, the frontal lobe came out with it. There is, however, another group of tumors which are more benign and are encapsulated, located not within but underneath the frontal lobe. In the past, neurosurgeons have been impeded in their attack upon these tumors by inability to retract the frontal lobe adequately enough to give them a good exposure. The result was that, often, for this reason only, these tumors could not be completely removed. Adequate exposure could have been obtained if the frontal lobe were removed. Surgeons have hesitated, in the past, to do this because they

felt by so doing they would leave the patient with an intellectual deficit. The present studies suggest that these subfrontal lobe tumors may be uncapped with safety, and the authors are already working on a group of cases having this type of frontal tumor in which the first step in the operative attack is clear exposure of the tumor by means of frontal lobectomy.

Discussion.—Dr. John Teitelbaum (New York)

A. The appended findings may be reported on group A, *i.e.*, those in whom the tumor mass was removed completely

(1) Complete *psychometric* and *psychiatric* studies showed little disturbance of function in this group. The nonpsychiatric observer would find it exceedingly difficult to say that there was *anything wrong* with these patients.

(2) *All patients were completely in contact with the past as well as the present life.* They are all able to function mentally, the same as they were before, and in the majority of cases on a much better level than before the operation. In conversation they make a good transference, discuss their problems frankly and openly. The study revealed that they are generous, kind-hearted, and interested in the welfare of their friends and families. Several of the patients have kept up an intelligent correspondence with some of the patients they met on the ward. They have retained their former abilities at cards, games, *etc.*

(3) The patients showed *no impairment of general intelligence.* They plan or execute business duties. One of them, three weeks after his return from the hospital, resumed his former employment, acting as inspector and taking care of his own account, as well as the accounts of eight men who work under him. All information gathered shows that his efficiency is as good as it ever was and that his mental functions are as keen as ever. He has to know by heart over 2,000 customers and keep their accounts; and if any of the eight drivers gets sick he is able to take his place as driver and make all deliveries correctly.

(4) The reactions presented by these patients are undoubtedly *colored by earlier drives*, and *personality* structure, as are all individuals. It would seem that their old patterns of reactions are either left the same or are modified in direction of more socially acceptable behavior.

(5) These patients have become *socially more adaptable* and *emotionally more calm.* The emotional adjustment was adequate and there was a complete return to their former emotional level. There was an improvement in their temper; they were less irritable, and more tolerant.

(6) All patients showed an *adequate response to humor.* The memory and insight into the feelings of others was unimpaired. In every case the humor was adequate and in good taste. One patient, who was always of a very serious nature and rarely showed much response to humorous conversation, now mentions jokes in her social groups, responds happily to comedy pictures (movies), and in every way has developed an adequate sense of humor.

(7) *The following changes which can be classified as being abnormal,* were noted. In two of the patients the examiner felt that there was a *lack of justifiable anxiety.* They were not concerned or worried about their future. They seemed to be perfectly satisfied to go on as they were. The patients of this group presented a *lack of distractibility* which was quite marked post-operatively, but which tended to diminish as time went on. When speaking or doing anything they could not very easily be distracted or turned to something new.

SUMMARY OF THE FINDINGS ON GROUP B, *i.e.*, THOSE PATIENTS IN WHOM THE LESION COULD NOT BE REMOVED COMPLETELY

The mental symptoms found in this group after observation, for 27 months, are still very numerous. None of them indicate any fundamental change in any mental processes, but only a disturbance of its completeness. The difference observed in these patients is a defect in the amount of this building process, thus limiting the degree of possible complexity of thought. The many symptoms to be enumerated flow from this deficiency, and as a result the personality becomes greatly altered.

On every-day tests these patients are able to function very well; some of them plan their meals, market, cook, bake, pay the bills, show interest in managing their home, and in taking care of their family. Some in this group show an improvement in character over their previous adjustments. A few, however, remain dull, lack initiative, efficiency, and planning. There is an emotional inadequacy. The feeling of the examiner is that they could not be pushed too hard in any task requiring more elaborate functioning. In other words, they are able to work on a simple level which is very likely slightly below the level under which they functioned prior to the development of the illness.

SUBDURAL HEMATOMA*

A STUDY OF ONE HUNDRED FORTY-THREE CASES ENCOUNTERED DURING A FIVE-YEAR PERIOD

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DURING the past 15 years a number of articles have appeared in the literature concerning cerebral subdural hematoma. Among these may be mentioned those by Putnam and Cushing[1] Gardner,[2] Peet and Kahn,[3] Jelsma,[4] Dyke,[5] Kennedy and Wortis,[6] Munro[7, 8, 9] Leary,[10] and Kunkel and Dandy[11] as representing noteworthy contributions relative to the pathogenesis, the diagnosis and the surgical treatment of this lesion. The publications of Donald Munro in particular have greatly influenced the trend of thought concerning the physiochemical changes that occur within and about a blood clot in the cerebral subdural space. Furthermore, he has repeatedly expressed the opinion that the chronic form of subdural hematoma is nothing more than a later variant of the acute phase, a concept with which we are in complete agreement. On the other hand, there is ample evidence to substantiate the opinion that subdural hematoma in the chronic form manifests different clinical findings from those evinced in the acute stage. In a series of cases here analyzed no attempt will be made to separate the acute from the chronic lesions. The period of time elapsing between trauma and verification of the clinical diagnosis in each instance has been tabulated, thus permitting the reader to arrive at his own classification.

From July 1, 1934, to July 1, 1939, 10,223 patients were admitted to the Neurosurgical Service of the Kings County Hospital with evidence of trauma to the intracranial structures. During the same period 42 patients with similar lesions were admitted to the Brooklyn Hospital. In the Kings County Hospital series there were 127 instances of subdural hematoma and in the Brooklyn Hospital group, 13 examples of this lesion. In addition three cases of subdural hematoma treated at the Long Island College Hospital have been included.

It is the object of the present study to consider the important observations made in these 143 cases of head injury which had as a complicating lesion, blood (fluid, clotted or organized) in the subdural space in sufficient

* Read before the New York Surgical Society, Febraury 28, 1940. Submitted for publication January 31, 1940.

amount to be of surgical significance (over 25 Gm.). All instances of surface brain laceration with a 1 to 2 mm. film of blood clot over and immediately about the laceration, although within the subdural space, have been excluded from the group under consideration. On the basis of the data derived chiefly from this study, the important aspects of the subdural hematoma will be discussed.

Etiology.—Trauma is the important agent in the production of subdural hematoma, although other causes have been encountered. For example, we have observed an extensive subdural hemorrhage from the region of a metastatic tumor implicating the pia-arachnoid, one from the vicinity of a cerebral abscess, two from ruptured cerebral aneurysms and one from an arteriovenous malformation on the surface of the brain. The classic pachymeningitis hemorrhagica interna of Virchow,[12] probably resulting from repeated small arterial hemorrhages, may also be included as an unusual type. In the group of cases here presented there were 133 in which the subdural hemorrhage was clearly the result of trauma, the site of the injury to the head varying considerably (Table I). As indicated, in approximately one-third of the

TABLE I

Trauma to the frontal area of the head	24
Trauma to the lateral area of the head	32
Trauma to the occipital area of the head	45
Trauma to multiple areas of the head	10
Trauma to unknown site	22
No trauma	2
Questionable trauma	8
	143

total number of cases there was evidence of a blow to the occipital region of the head. Most of the hematomata appeared to be venous in origin, although some resulted from arterial bleeding. There were examples in which no doubt could be entertained regarding the source of the blood clot, such as a rent in the dura with a tear of the meningeal artery caused by a fracture of the skull. A cerebral artery may be the source of the bleeding, seven cases having been observed in which there was a blood clot in the subdural space and in the adjacent cerebrum itself, both the result of a traumatically opened artery. Venous bleeding may occur from ruptured veins that cross from the cerebrum to the dura mater. A vein, almost constantly present, that may easily be torn as the result of trauma, is situated at the anterior aspect of the sylvian fissure and crosses the subdural space where it joins the sphenoparietal venous sinus (Fig. 1). Other veins observed to be the source of bleeding are those crossing or impinging upon the subdural space in the parasagittal region. These veins are more frequently traumatically opened in instances in which the cranial vault is grossly distorted, as occurs in the passage of the infant through the pelvic canal. Laceration and/or contusion of the surface of the brain implicating cortical blood vessels are much more commonly the origin of bleeding. In fact in our experience, fully 75 per cent of all subdural

hemorrhages can be traced to such a lesion. In some instances it is difficult, even at autopsy, to definitely identify the origin of the blood clot, particularly if several days have elapsed since the injury or when there are multiple areas of traumatized cerebral surface adjacent to the hematoma.

Pathogenesis.—In a discussion of intracranial lesions dependent upon trauma complicated by subdural hematomata, it seems permissible to incorporate certain general information acquired at autopsy on subjects other than the cases included in this series. Furthermore, the information amassed from

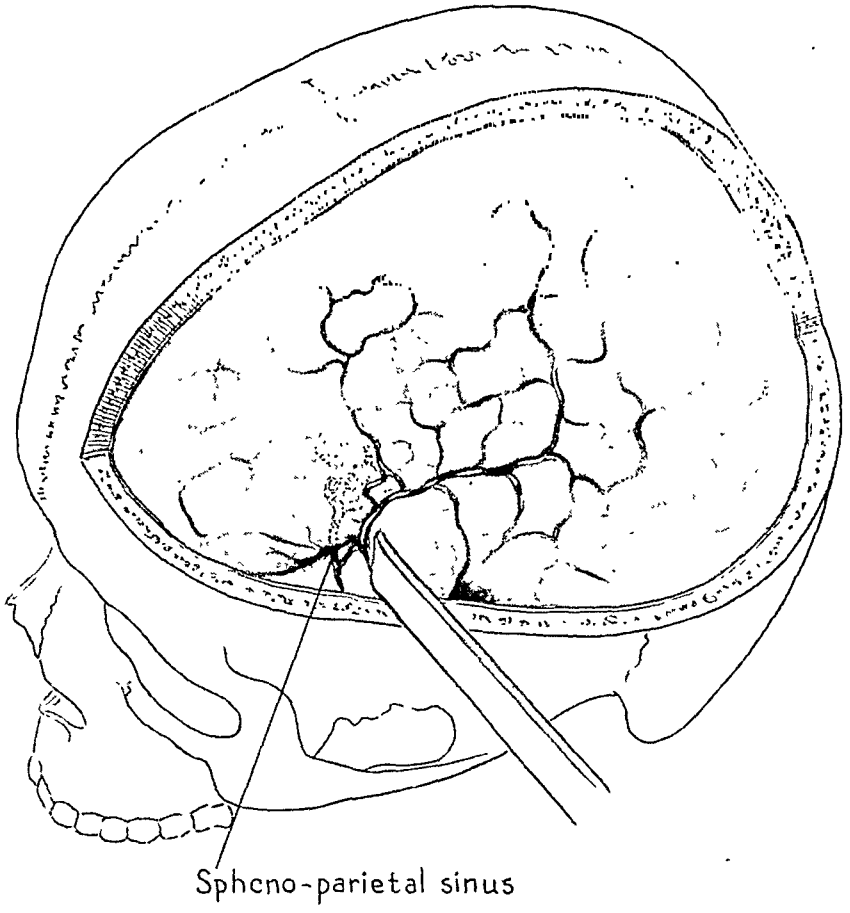


FIG. 1.—Drawing showing a vein not infrequently lacerated by trauma to the head. For illustrative purposes it was necessary to make the vein appear twice as long as observed in the average anatomic specimen.

the autopsy material is much more reliable than impressions gained from inspecting the intracranial contents through an operative opening. There is found great variation in the position, size and consistency of the subdural hemorrhages. In the series under review there were 71 hematomata in the left subdural space and 62 on the right side. In ten cases the blood clots were found bilaterally. Some were limited more or less to the temporal fossa, many were higher in position and thickest over the premotor area, while others covered almost the entire convexity of the cerebral hemisphere (Fig. 2). The lesion was encountered in the posterior fossa in two cases. The weight

of the clots varied from 25 to 350 Gm. The subdural collections were observed to be clots, fluid, organized masses or a mixture of these in various



FIG. 2.—A "classic" example of a fresh subdural hematoma.

TABLE II

Elapsed Time from Injury to Operation or Death	2 to 24 Hours	24 Hours to 4 Days	4 to 8 Days	8 to 13 Days	13 to 17 Days	17 to 26 Days	26 to 36 Days	36 Days to 3 Mos.	Total
Fluid blood.....	7	5	5	6	9	4	5	2	43
Clotted blood....	17	8	10	2	1	1	2		41
Clots mixed with fluid.....	8	8	8	3	3	5	3		38
Clot organized....					1			1	2
Hydroma.....		1				1			2
Insufficiently described.....									17

proportions (Table II). It may be noted from Table II that sufficient description was not recorded in the case histories to definitely classify the types of subdural collection in 17 instances. The time intervals used are the same as those employed by Munro.[9] The object of this selection was to compare the data of our series with those reported by him. The findings in our series indicate that large solid blood clots have seldom been encountered later than eight days after their establishment in the subdural space. In the unusual instances in which the hematomata remained solid after the first eight days, fibroblastic invasion of the clot was demonstrable. The findings further show that fluid blood, as well as the combination of clotted blood and fluid, was disclosed in a relatively large number of cases operated upon within eight days after injury. In general, it may be fairly stated that there was no gross pathologic evidence derived from the study of the types of subdural collections recorded in our series to refute the theoretic concept set forth by Gardner[2] and elaborated by Munro. Their theoretic explanation that a subdural hematoma may be augmented by osmosis in a certain number of such lesions seems entirely logical. There are other types of subdural collections in which the physical characteristics are so bizarre that it becomes difficult to interpret them in terms of this concept. These escape classification not only with reference to their formation and consistency but also as to the development of a surrounding membrane, subsequent changes within the clot and residual pathologic states. For example, in the series of cases that were operated upon on the fifth day following the injury, one finds such variations as collections of black glistening oil-like fluid, brownish-black coffee-ground-like material, solid liver-like clots, thick homogeneous tar-like blood and combinations of blood clot and thin, dark brown fluid. It, therefore, becomes obvious that there are factors governing the alterations that may occur in a subdural hematoma concerning which there seems to be no sound theoretic explanation. It might be suggested that the changes in consistency which take place in some hematomata are partly attributable to the variations in the rapidity and possibly the manner of formation of the membrane that eventually encases all fluid subdural collections. In some instances a definite membrane has been demonstrable as early as the fourth day, whereas in others in which the clots had the same physical appearance there was scanty or no membrane formation on the eighth to the tenth day following injury. In other examples in which no liquefication of the hematoma occurred, the cellular elements that comprised the membrane were relatively thin on the surface of the clot, and, depending on the age of the lesion, cells resembling fibroblasts were found to have invaded the hematoma to a variable extent. The membrane adjacent to the dura (outer membrane) has been observed in all cases to be thicker than that in apposition to the arachnoid (inner membrane); however, both membranes are seemingly formed at about the same time. The simultaneous development of an inner and outer membrane about a fluid collection tends to throw some doubt on the hypothesis that the dura is the sole origin of the cells forming the membrane. It seems unlikely that an outgrowth of cells

from the inner surface of the dura would proliferate with sufficient rapidity to cover the inner area of hematomata of the size encountered in this series, within four to five days. In addition, the presence of blood in the subdural space may not be a necessary factor in the production of a membrane about a subdural collection. A 60 cc. sterile subdural hydroma with well-established inner and outer membrane has been observed in association with multiple metastatic foci of infection within the brain (Fig. 3). Since the fluid of this particular hydroma was yellowish in color, it may be contended that



FIG. 3.—Section showing subcortical metastatic focus of infection associated with a subdural hydroma.

red blood cells or their derivatives were present and essential for the formation of the membrane. In general it may be said that most fluid subdural collections become enclosed by a cellular membrane, thicker on the outer (dural) and thinner on the inner (arachnoidal) side, that some solid clots become encapsulated and undergo central liquefication and that other solid hematomata are invaded by fibroblastic cells without evidence of dissolution.

The type of brain lesion sustained in association with subdural hematomata may also be a factor that governs the consistency of the subdural collection. Hemorrhage from a traumatically opened vein that traverses the subdural space without injury of the brain itself should result in a different type of subdural collection from that following contusion-laceration

of the cortical surface with the attendant opening of the subarachnoid space. In the latter instance the blood in the subdural space would be diluted with cerebrospinal fluid, thereby affecting the clot formation. The laceration of the brain heals, leaving a small zone of cortical atrophy covered with thickened pia-arachnoid. All stages of such healing processes have been observed, from the fresh, reddish-brown subpial hemorrhage surrounding a zone of brain laceration to the milky white pia-arachnoid adherent to the inner membrane of a subdural collection. One cannot infer from the appearance of the cortical surface at operation, the extent of the pathologic process that had been present.

There were 136 of the 143 patients in this series who had examinations of the skull roentgenologically or at autopsy. Sixty had fractures of the skull, and in 76 cases no fracture was demonstrable. As previously stated, there are rare instances in which a fracture of the skull has resulted in a laceration of a meningeal artery and the dura, thereby opening an avenue for the arterial blood to gain entrance to the subdural space. There were six cases in this series that had both extradural and subdural hematomata. The extradural hematomata were proportionately small, consequently these cases are included in the subdural series. In three instances the clots were on the same side, in two cases the subdural collection was on the opposite side to the epidural hemorrhage, and in one there were bilateral, small extradural with unilateral subdural hematomata. Subdural hemorrhage is an occasional finding in association with compound depressed fracture of the skull, but this type of case has not been included in this series. In practically all instances of subdural hematoma the presence or absence of fracture of the skull has very little related significance. From the evidence at hand one may reasonably state that subdural hematoma is a lesion resulting from trauma to the head and is frequently found with any or all of the following: Lacerations of the scalp; hematomata beneath the scalp; all varieties of fracture of the skull; extradural hemorrhage; contusion-laceration of the cerebral cortex; intracerebral blood clots; and intraventricular hemorrhage.

The patients who survive the acute phase of the craniocerebral insult make up the group that come to operation or autopsy at a later date and are usually designated as chronic subdural hematoma. In these cases the finding of obvious edema of the brain adjacent to a long-standing subdural collection (Fig. 4), encased by a fibrotic membrane, strongly suggests that the symptoms of a space-occupying intracranial lesion, appearing after a considerable interval has elapsed following the trauma, are due to this edema of the brain rather than increase in the fluid content of the subdural collection.

Symptoms, Physical Signs and Diagnosis.—The majority of patients harboring a subdural hematoma present evidence of a recent trauma to the head or later, when seeking medical counsel after an interval of relative freedom from symptoms following the injury, admit a previous accident. There are a few from whom no history of trauma can be obtained either by direct questioning or from the relatives. In this series there were two cases in which

trauma could be excluded as an etiologic factor. In 101 cases the injury to the head resulted in immediate unconsciousness; 22 patients were not rendered unconscious by the blow; and in the remaining 18 cases the exact state of consciousness after the trauma could not be ascertained. Of the 101 instances in which there was an unquestionable period of unconsciousness immediately following the trauma, there was an interval of lucidity before secondary stupor supervened or before operative intervention in 52. Thirty-six of the remaining 42 patients were in stupor or coma from the time of injury until operation was performed or until death occurred. Eighteen of these 36 patients were operated upon, with only two recoveries. Evidence of recent consumption of alcohol was present in 68 cases. Convulsions occurred in ten cases. Headache, vomiting, double vision, weakness or numbness of the extremities on one side, and stiffness of the neck were recorded in various combinations but these could be considered of value only when present during the late or chronic phase of the disorder. Vomiting was noted in 57 cases and headache in 79. The patients who were initially unconscious following the trauma and subsequently became oriented, presented one quite characteristic type of behavior. Noticeably during the so-called lucid interval, many were observed to lapse from a cooperative and alert state into a stupor within a period of 20 to 30 minutes, shortly to be followed by a return to the previous conscious level. Several such cycles were apt to occur in a single day. While this sequence of events may be observed in association with conditions other than subdural hematoma in combination with obvious trauma, it suggests the presence of a "compression lesion" rather than an intrinsic pathologic process of the brain. After three weeks to a month, symptoms are commonly more clearly defined, although in some instances they appear to be entirely unrelated to a trivial accident that has long since been forgotten. More often the persistence of paroxysmal headache will link the illness to a previous trauma of the head. The concomitant symptoms that occur during the chronic phase are usually those associated with any space-occupying lesion of the intracranial cavity.

The important physical findings to be given consideration during the acute phase of subdural hematoma are usually limited to the obvious external evidence of trauma, the state of consciousness, the condition of the pupils, the appearance of the optic fundi, gross alterations in facial movements, gross weakness of an extremity or of the extremities on one side, and the status of the superficial and deep reflexes. The state of consciousness is usually such that precision in neurologic examination is impossible. The abnormal recorded findings that were reviewed in this series are difficult of evaluation, since many no doubt were the result of intrinsic brain damage (petechial hemorrhages, edema, laceration, *etc.*). Repeated examinations are important, for changes in physical signs are regarded as being of more significance than the information obtained at any one examination. The age of the patients in the present series ranged between 14 months and 80 years. Most were in the fifth decade of life. The pupils were recorded as being equal in 59 and

unequal in 72 cases. Only 12 of the latter showed an unequivocal wide dilatation of the pupil on the same side as the blood clot and in one of these cases there was a bilateral subdural hematoma. In this instance the larger clot was found at operation to be on the same side as the dilated pupil. The pupil was larger on the same side as the lesion in 32 cases but could not be considered as "dilated." Twenty-six cases had the larger pupil on the contralateral side with respect to the hematoma. There were two examples of bilateral subdural hematoma in which the pupil was observed to be larger first on one side and then on the other (shifting dilatation of the pupil). The state of the pupil in the remaining 12 cases in this series was not recorded with sufficient detail to permit accurate classification. Papilledema was recorded in 50 of the 143 cases. This included all grades, from slight blurring of the superior nasal border of the optic disk to the most marked degree. Here again, one could not be sure that the presence of the blood clot in the subdural space caused the edema about the optic disk, or whether the clot in combination with diffuse brain changes dependent on the trauma resulted in increased intracranial tension. Nuchal rigidity was observed in 57 cases. The most striking rigidity of the neck has been noted in association with blood in the cerebrospinal fluid. This rigidity has frequently been interpreted as representing the reaction to the blood in the spinal subarachnoid space; however, there are many instances in which such rigidity has been observed following uncomplicated trauma to the head, while the cerebrospinal fluid was found to be normal. Unilateral paresis of the face, central type, was observed in 80 cases. In 22 cases the facial weakness was on the same side as the subdural hematoma and in 58 instances it was contralateral. Facial paresis without demonstrable weakness of the homolateral extremities was recorded in 15 cases. A hemiparesis implicating the motor power of the face and upper and lower extremities of one side was recorded in 61 cases. The motor weakness was contralateral to the subdural lesion in 42 cases and homolateral in 19. The abdominal reflexes were absent bilaterally in 99 cases and not present on the side of the motor weakness in 20. Babinski's sign was present bilaterally in 67 cases and unilaterally (side of motor weakness) in 25. The scanty information derived from the sensory examinations was unreliable. Incontinence of urine was recorded in 108 of the 143 cases. Bradycardia (pulse rate below 70 per minute) was present in 63 cases. The cerebrospinal fluid pressure was elevated in 79 cases (above 15 Mm.Hg.), the fluid contaminated with blood in 80 cases, xanthochromic in 30 cases and clear and colorless in 19.

A clinical diagnosis of subdural hematoma can be made during the acute phase of the disorder with a fair degree of certainty provided only a moderate grade of trauma has resulted in a loss of consciousness for 48 to 72 hours, followed by a few days of lucidity and then a recurrence of the stupor. There are a few cases in which only a momentary alteration of the conscious state, the consequence of the initial insult, is succeeded by normal activity for a few hours to several days and then by progressively increasing drowsiness. This

simulates extradural hemorrhage from which it can be differentiated only by an exploratory bur opening in the skull or by air studies. A third group of the acute cases includes those that remain in coma from the time of injury until the blood clot is removed at operation or until death. The lesion most difficult to differentiate from subdural hematoma is contusion-laceration of the temporal or frontal lobes of the brain with regional edema. This intrinsic lesion of the brain is frequently associated with a subdural hematoma, the source of which is often a ruptured cortical vessel at the site of the laceration. Differentiation of these two lesions on clinical grounds alone is usually impossible. Even by air studies the roentgenographic findings, while demonstrating a shift of the ventricular system, may not clarify the issue. Chronic subdural collections of months' standing are difficult to distinguish from cerebral neoplasms; in fact, the diagnosis is usually made at operation. In any event, a patient who has sustained a head injury, trivial or severe, and subsequently presents evidence that the intracranial structures have been damaged and who does not show progressive recovery, should have biparietal bur holes made in the skull. If upon opening the dura no evidence of subdural bleeding is disclosed, then a ventriculographic study should be carried out and further surgery performed if indicated. One cannot rely upon inequality of pupils as a guide to the side of the lesion unless there is constant unequivocal wide dilatation of one pupil. Furthermore, a well-established hemiparesis does not indicate the side of the lesion in many cases. In this series of 143 cases, weakness of both upper and lower extremities on the same side as the lesion was present in 19 cases, whereas a contralateral hemiparesis was observed in 42 cases. In the last analysis only a presumptive diagnosis of subdural hematoma can be made in a vast majority of instances on evidence derived from clinical examination alone. Visualization of the lesion through a bur opening in the skull, or air studies of the cerebral ventricular system with subsequent verification of the lesion at operation, are the means of establishing the diagnosis.

Roentgen-ray Examination.—Plain roentgenographic studies of the head are of distinct value in many cases. The presence or absence of a fracture of the skull aids little in the diagnosis of subdural hematoma. A demonstrable shift from the midline position of a calcified pineal body is confirmatory evidence that a space-occupying lesion is present and indicates the side of the lesion. If trauma to the head has been sustained it is logical to assume that the space-occupying mass is a blood clot. A mild shift of the pineal may occur in simple edema of one cerebral hemisphere following trauma and the same may be said of a shift of an air-filled ventricular system. The most important application of the roentgenologic study of the head with particular reference to the diagnosis of subdural hematoma is made after the introduction of air into the ventricular system. One of two methods may be utilized—encephalography or ventriculography. The former method of examination was employed preoperatively in 45 cases in this series and the latter in 27 instances. In 19 of the 45 encephalograms, air failed to enter the ventricular

system, although in several of these failures air was present in the cerebral subarachnoid space and the side of the lesion could be determined by the position of the falx cerebri. The injection of air by way of the lumbar subarachnoid space seemed to have been a factor in the subsequent death of one patient.



FIG. 4.—Subdural hematoma of three months' duration. Note the edema implicating the capsular zone on the side of the hematoma.

The 27 ventriculographic studies clearly indicated the side and position of the lesion. The air studies carried out on patients in the acute phase of their illness gave evidence that a space-occupying mass was present and suggested a diffuse compression of one or the other cerebral hemisphere. The sharply defined defect in the ventricle produced by a chronic circumscribed hema-

toma resembled the roentgenographic findings associated with meningiomata. Eight verified cases of edema of a cerebral hemisphere, not included in this series, showed a shift of the ventricular system in every respect similar to that produced by subdural hematoma. During the past two years there has been a tendency toward preference for the direct introduction of air into the ventricular system, although spinal subarachnoid injection of 40 to 50 cc. of air has been employed in selected cases without deleterious effects.

Treatment.—There is but one form of treatment for subdural hematoma: surgical removal of the blood clot. Multiplicity of intracranial lesions dependent on the injury that initiated the subdural bleeding are frequently present. Removal of the subdural collection without continued supportive treatment as has been outlined elsewhere[13] will frequently be followed by a fatal outcome. As would be expected, if the patient can weather the storm during the first three or four days following the injury, the chances for recovery are greatly enhanced. Table III illustrates this very clearly. On the other hand, some patients are saved by an operation performed during the first three or four days after the traumatic insult to the brain. Table IV illustrates that it is not necessarily the size of the clot that determines the outcome.

TABLE III

Elapsed Time between Injury and Operation	Total	Recovered	Died	Mortality
2 to 24 hours	24	4	20	83.3%
1 to 7 days	38	23	15	39.4%
7 to 14 days	17	11	6	35.3%
14 to 21 days	19	16	3	15.7%
21 to 28 days	5	4	1*	20.0%
Over 28 days	8	8	0	

* Patient reported in text to have had a subdural collection associated with multiple metastatic foci of infection in the brain.

TABLE IV

Weights of Clots	Total	Operated and Recovered
10 to 25 Gm.	2	1
25 to 50 Gm.	5	3
50 to 75 Gm.	54	24
75 to 100 Gm.	34	7
100 to 150 Gm.	35	24
Over 150 Gm.	13	7

Knowledge derived from statistics, however carefully compiled, has certain limitations in its application. Repeated review of our results in the treatment of patients with subdural hematomata has from time to time modified the method of managing these patients. No absolute standard is adhered to, since a considerable flexibility of thought is desirable and advantageous in the treatment of each individual. Conservative treatment of patients immediately after a craniocerebral injury is indicated except in those instances in which a mild to moderate degree head injury associated with unconscious-

ness is followed by a lucid interval and then within a relatively short period of time by stupor. If after a 10- to 20-hour period of observation, the vital signs and the conscious state indicate that they are not doing well on a conservative therapy, and the physical signs suggest the probability of a complicating intracranial hemorrhage, operation is performed. With the patient in the face-down position on a cerebellar outrigger, bilateral bur openings are made in the skull slightly more distant from the midline and somewhat anterior to the conventional position used for ventricular puncture. If upon opening the dura a fluid subdural collection is encountered, this is evacuated. If the hematoma is solid a small bone flap is turned down and the clot removed. In the event that no subdural collection is disclosed through the bur holes but the clinical findings suggest the presence of an intracranial hemorrhage, ventriculographic studies are performed. If the roentgenologic findings indicate the presence of a blood clot the patient is returned to the operating room for its removal. This general outline of therapy applicable to many patients during the first four or five days following injury (and in our opinion frequently mandatory) is not pursued if it is estimated by the clinical course that they may survive the acute phase of the injury. The mortality is high during this period but it can be somewhat reduced by judiciously applied surgery. Many of the subdural collections are solid clots during the first few days, and consequently require a bone flap for proper removal. After eight to 12 days some of these become liquefied and can be evacuated through a bur hole in the skull. Once a patient has recovered from the immediate effects of a brain injury, yet, as judged by the clinical course. a subdural hematoma is present, operation should not be unduly delayed. It is far better to perform a ventriculogram in the absence of a blood clot than to permit a patient with a subdural collection to lapse into a secondary stupor, at which time the removal of the clot may be of no avail.

The chronic phase of subdural hematoma presents no particular therapeutic problem unless the patient is admitted to the hospital in coma, requiring prompt attention. If at operation the bur opening is made over the hematoma, the thick outer membrane may be incised and the contents of the hematoma, if liquid, evacuated. Failure to disclose the lesion beneath the conventional posterior site for bur openings made for ventricular puncture should be followed by air studies and a small flap turned down over the involved area. Upon exposing the outer membrane it is not necessary to cut an opening more than 3 to 4 cm. in diameter to completely evacuate the contents of the subdural collection. The outer membrane of a chronic lesion is quite vascular; therefore, the incision through this structure should be made with the electrocoagulating unit. Absolute hemostasis is essential. The relatively fresh blood clots offer few technical difficulties but the chronic, fibrosed lesions may be intimately attached to adjacent blood vessels. The latter type should be removed piecemeal as is required in some meningiomata.

Discussion.—The frequency of occurrence of subdural hematoma in this five-year study, 143 in 10,265 cases of cerebral injuries, is much less than

that reported by other authors.[9, 10, 14] Several reasons present themselves in explanation of this discrepancy. All instances of laceration of the brain with a layer of blood clot over the site of laceration and some in which there was a small amount of subdural blood clot about the laceration have been excluded



FIG. 5.—Small subdural hematoma taken from the zone of contusion-laceration as shown.

from this series (Fig. 5). It is our belief that most patients suffering such pathologic states recover, and in support of this contention two autopsy specimens recently examined will be referred to as examples of what may happen to similar lesions in others. The story of a previous accident was obtained in both cases, one sustaining a head injury about one year previously, and the other approximately eight months before the fatal issue. Both subjects

had died as a result of a second craniocerebral injury, and at autopsy a fresh blood clot was disclosed over one cerebral hemisphere, whereas on the other side a tough, fibrosed homogeneous structure 3 to 4 mm. in maximum thickness occupied the subdural space. During the periods between the accidents one patient was said to have been free of symptoms and the other patient had recurrent episodes of headache although able to perform manual labor. There was ample evidence in both specimens to show that the older subdural collections followed lacerations of the temporal lobes. Furthermore, many small clots of the character illustrated by Figure 5 have been exposed at operation and the lesions classified as cerebral contusion-laceration of the brain. Approximately one-half of the 10,265 patients with head injuries presented evidence of mild brain trauma, and it is possible that a few with unrecognized subdural collections of one character or another were discharged free of symptoms but subsequently admitted to other hospitals. Two instances in this category are definitely known. No doubt many of the patients with chronic subdural hematomata that have been reported in the literature are individuals who have largely recovered from a mild head injury, and because of an exacerbation of symptoms have eventually been directed to institutions where cranial surgery is being performed.

The position of a subdural hematoma does not necessarily signify the region from which the bleeding occurred. Many autopsy specimens have been examined which disclosed a laceration of the temporal and/or the orbital surface of the frontal lobe associated with a sizable hematoma in the parasagittal position (cases similar to that illustrated in Figure 2), yet no injury to the crossing veins in this region could be demonstrated nor could the slightest attachment of the blood clot to the underlying pia-arachnoid be shown. Most chronic subdural hematomata are located in the parasagittal region, and because of this it appears that many authors have expressed the opinion that the blood vessels here are frequently opened traumatically. In view of the findings at autopsy in many fresh specimens, it seems probable that a subdural collection may eventually assume a position somewhat distant from the original source of bleeding. Secondary hemorrhages are reported to occur from the outer membrane of a long-standing subdural collection. We have never recognized this lesion in any of the material examined. There can no longer be any question that the pathologic lesion, brain trauma complicated by a subdural hematoma, undergoes changes that result in sufficient increase in volume on the affected side to cause a progressive shift of the cerebral ventricular system (Fig. 6). This has been clearly demonstrated by series of air studies in several instances. While it may be held that this progressive displacement of the ventricular system may be caused by edema of the brain adjacent to the blood clot, it has been observed that patients in whom this increasing shift has been demonstrated may be showing clinical improvement. It seems unlikely that recovery from stupor and improvement in motor activity of a previously paretic extremity would go hand-in-hand with an increasing displacement of the ventricular system away from the lesion if the

increment were due to brain edema. Another interesting fact disclosed by repeated air studies on patients with subdural hematoma is worthy of comment. The initial air study always shows, as would be expected, a relative narrowing of the lateral ventricle on the side of the lesion and mild to moderate dilatation of the contralateral ventricle. Studies carried out after removal of the blood clot demonstrate that this inequality in size of the lateral ventricles remains, although both frequently become moderately dilated (Fig. 6C). This observation has been verified as late as one year after the evacuation of a subdural collection.

There were two examples of hematoma located in the subdural space of the posterior fossa included in this series and, in addition, we have observed

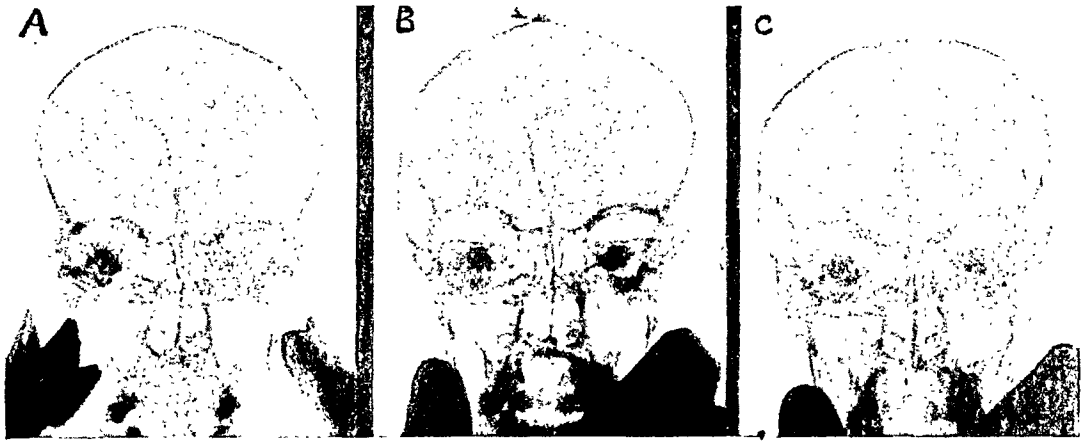


FIG. 6.—A series of roentgenograms representing changes in the size of a subdural collection. (A) Anteroposterior view showing a mild displacement of the ventricular system on the seventh day following injury. (B) The same view at a second examination 18 days later. Note the advance in the ventricular shift. (C) Third examination 10 days after surgical removal of an hematoma.

three other cases prior to 1934. A clinical diagnosis of this lesion has never been made; in fact, in only one of these five cases was this diagnosis entertained as a probability. Although the ventriculographic findings in one instance disclosed a mild symmetric dilatation of the lateral ventricles that were centrally placed, the deductions, from all the evidence at hand, did not lead to the correct conclusion. The clinical diagnosis of posterior fossa neoplasm was made in three children, all of whom showed only two abnormal physical findings: high degree of choked disk and unsteadiness of gait. A fluid subdural hematoma was disclosed in each instance upon making bur openings for ventriculographic studies. Spinal puncture had been performed in each of these three cases and the fluid found to be clear and colorless. As previously stated, there were all together 22 cases in the series that showed clear cerebrospinal fluid, although many had spinal punctures performed on several occasions during the acute phase of the illness. Furthermore, the pressure of the cerebrospinal fluid may be high, low or normal. Several verified instances of large subdural collections have been found to show very low cerebrospinal fluid pressures as measured in the lumbar thecal sac. In some cases this low intracranial pressure was substantiated at operation by the fact that upon opening the outer membrane of a subdural collection through a small

cranial opening only a few cubic centimeters of liquid blood were discharged. After washing out 100 to 150 cc. of old fluid blood, some patients regain consciousness while still on the operating table. Upon inspecting the brain through the cranial opening, the cortical surface would commonly be found at a level 2 to 3 cm. below the under surface of the dura. We have been unable to interpret these findings in terms of the generally accepted concept regarding the relation between intracranial pressure and altered conscious states. Not infrequently under the above conditions, a patient will remain conscious for 18 to 24 hours after removal of a hematoma and then become stuporous again. After dehydration therapy an uneventful recovery usually ensues. The secondary stupor has been thought to represent cerebral edema depending upon postoperative expansion of the compressed brain. It has also been observed, especially in older patients, that a failure of the brain to resume its normal contour shortly after the removal of the blood clot is an unfavorable prognostic sign.

The adage that a subdural collection of blood (fluid, clotted or a mixture of the two) should be removed once the diagnosis has been established, is fallacious in our experience. A study of Table III clearly indicates the high mortality attending operations performed during the first 24 hours following injury. The fatalities could not be considered attributable to the operation *per se* in view of the severe brain injury found to be present. In each patient operated upon within 24 hours after injury, it was believed from the clinical course that death would certainly ensue unless some measure were instituted to alter the downhill trend of events. We have concluded from experiences during the past nine years that a greater percentage of the severely injured who have as a complication a subdural hematoma will survive if the hematoma is removed, even during the first 24 hours, than through the institution of conservative measures during the early acute stage and operation at a later date. The records indicate further that those not so seriously injured and who survive for two weeks or longer have an excellent chance for recovery following the removal of the hematoma. Operations performed during the chronic stage should carry a very low mortality. The 32 patients (Table V) that were not operated upon are all examples of severely injured

TABLE V

Patients operated	111		
Recovered	66		
Postoperative deaths	45	Operative mortality	40.9%
Not operated	32	Mortality	100.0%
Total deaths	77	Total mortality	53.8%
Autopsies	68	Autopsies	88.3%

who died shortly after admission and in whom the lesion was verified at autopsy. A subdural hematoma was suspected to be present in many of these on the basis of clinical findings, but in each instance the general physical states were such that operation was thought to be inadvisable. Approxi-

mately one-half of those who recovered have been followed in the Out-Patient Department. The sequelae (headache, dizziness, convulsion, *etc.*) that have occurred among these have been in about the same proportion as that encountered in any group of patients who have sustained moderate to severe trauma of the brain. Three patients were committed to psychiatric care but these recovered, on the average, in one year's time and were discharged from the hospital.

CONCLUSIONS

The important features relative to the etiology, pathogenesis, diagnosis and treatment of subdural hematoma, as revealed by a study of 143 cases, have been presented. This series of cases encountered in a five-year period (July 1, 1934, to July 1, 1939) represents all patients in whom this lesion was verified either by operation or at autopsy. The data derived from the study indicate that in most instances subdural hemorrhage arises from a laceration of a cortical vessel resulting from trauma to the head. Frequently there is a concomitant traumatic lesion of the brain, the effects of which cannot be delineated from those produced by the blood clot in the subdural space. Some patients are obviously so seriously injured that no benefit can be derived from surgical measures. Many others surviving the cerebral insult for a few hours to a day, and presenting clinical evidence that a fatal outcome may be expected, are not improved by the removal of the subdural hematoma. A few so injured will recover and the recovery can, in the main, be attributed to the prompt removal of the blood clot. The clinical course of some patients who survive the acute phase of a cerebral insult accompanied by a subdural hematoma suggests that an increase in the size of the subdural collection may occur. Encephalographic studies repeated at varying intervals in instances in which a subdural collection was shown to be present, have demonstrated a progressive shift of the ventricular system away from the lesion. This advancing shift of the ventricles seems to result from an increase in the volume of the subdural collection. Whenever doubt exists regarding the diagnosis of subdural hematoma, air studies may be utilized to great advantage in clarifying the issue. Surgical removal of a subdural collection is the only therapy. If feasible, operation should be deferred until the acute effects of the injury of the intracranial structures have moderated.

REFERENCES

[1] Putnam, T. J., and Cushing, Harvey: Chronic Subdural Hematoma. Arch. Surg., 11, 329, 1925.

[2] Gardner, W. J.: Traumatic Subdural Hematoma with Particular Reference to the Latent Interval. Arch. Neurol. and Psychiat., 27, 847, 1932.

[3] Peet, M. M., and Kahn, E. A.: Subdural Hematoma in Infants. J.A.M.A., 98, 1851, 1932.

[4] Jelsma, F.: Chronic Subdural Hematoma; Summary and Analysis of 42 Cases. Arch. Surg., 21, 128, 1930.

[5] Dyke, C. G.: A Pathognomonic Encephalographic Sign of Subdural Hematoma. Bull. Neurol. Inst. N. Y., 5, 135, 1936.

[6] Kennedy, Foster, and Wortis, Herman: Acute Subdural Hematoma and Acute Epidural Hemorrhage. Surg., Gynec. and Obstet., 63, 732, 1936.
[7] Munro, Donald: The Diagnosis and Treatment of Subdural Hematoma. New England Jour. Med., 210, 1145, 1934.
[8] Munro, Donald, and Merritt, H. H.: The Surgical Pathology of Subdural Hematoma. Arch. Neurol. and Psychiat., 35, 64, 1936.
[9] Munro, Donald: Craniocerebral Injuries. Oxford Med. Public N. Y., 1938.
[10] Leary, Timothy: Subdural Hemorrhages. J.A.M.A., 103, 897, 1934.
[11] Kunkel, P. A., and Dandy, W. E.: Subdural Hematoma, Diagnosis and Treatment. Arch. Surg., 38, 24, 1939.
[12] Virchow, R.: Hematoma Durae Matris. Verhandl. d. Phys.-Med. Gesellsch. zu Würzburg, 7, 134, 1857.
[13] Browder, Jefferson, and Meyers, Russell: A Revaluation of the Treatment of Head Injuries. ANNALS OF SURGERY, 110, 357, 1939.
[14] Vance, B. M.: Fractures of the Skull. Arch Surg., 14, 1023, 1927.

DISCUSSION.—DR. CHARLES ELSBERG (New York) asked if he had understood Doctor Browder to say that he believed the symptoms of increased pressure that occur from subdural hematomata are due not to added fluid but rather to edema of the brain. If chronic subdural hematoma is a continuation of the acute stage, how is it that a slowly advancing papilledema, as evidence of increased intracranial pressure, occurs in patients who did not have evidence of increased pressure for many months? When one operates upon such a patient and evacuates the hematoma, it is lined both on the undersurface of the dura and against the pia arachnoid by a soft membrane. If one splits that membrane one very often sees the brain gradually bulge to only a slight extent. How could edema of the brain explain a condition of that kind?

Much has been said regarding the treatment of subdural hematoma merely by the making of trephine openings and the evacuation of fluid with blood clot and organized material. Doctor Elsberg's experience, during the course of many years, has been to find that while such a procedure would relieve conditions somewhat, the real relief of pressure upon the brain is obtained only when the inner membrane has been split, and usually a large amount of it excised.

Was not Doctor Browder speaking of an acute process with injury to the brain and secondary edema to the brain rather than of a chronic subdural hematoma?

DR. ERNEST SACHS (Washington University Medical School, St. Louis, Mo.) said that if he understood Doctor Browder clearly, he was inclined to believe that chronic subdural hematoma followed acute subdural hematoma, and that the increase of a subdural hematoma, an undoubted occurrence, is not due to the accumulation of fluid as believed by many and proven rather strikingly some years ago by Gardner in Cleveland. Doctor Sachs cited a case which in his opinion indicated beyond doubt that chronic subdural hematomata do increase in size. Some years ago he saw a patient who gave the history that while tobogganing with his wife they were both thrown off. His wife, although unconscious, proved to be only slightly injured. He, however, after recovering apparently completely, noted, five months later, symptoms of unilateral paresis, until finally he had the typical picture of an intracranial expanding lesion. At operation, he had a huge subdural hematoma. Unquestionably, he sustained a slight trauma at the time his wife was injured and may have had a clot such as Doctor Browder spoke of at the time of the injury, but something happened in the course of five months to give that man

symptoms. The thing that happened was that the subdural hematoma increased in size, and did so because the sac contained fluid. Where did that fluid come from? Certainly, one cannot suppose that a vessel oozed for five months. The contents of a subdural hematoma is fluid, as Gardner showed in one case where he completely removed the membrane and obtained fluid, proving that fluid did enter the membrane. This and similar experiences have convinced Doctor Sachs that chronic subdural hematomata do increase in size from the time they first form.

Another point that caused Doctor Sachs to wonder, was whether the kind of subdural hematomata that Doctor Browder spoke of and chronic subdural hematomata are the same sort of thing, just in a different stage, because, in the experience of most surgeons, chronic subdural hematomata very frequently occur bilaterally. In Doctor Browder's series of 143 cases he had only ten bilateral hematomata. That is certainly very different from the experience of most people with chronic hematomata.

A third point with which Doctor Sachs could not quite agree was with regard to treatment. During the early days he believed that the thing to do was to turn down a flap and remove the subdural hematoma, but in recent years, as cases have been seen increasingly, he has been completely won over to the other point of view, namely, that of his associate, Doctor Furlow. First bur-openings are made on each side to determine whether there is an hematoma, and, if so, it is washed out. As a rule, apparently, if the contents of the hematoma are thus thoroughly evacuated, the membrane takes care of itself. If, after trying this simpler procedure, the patient is not completely relieved, a bone flap is turned. Doctor Furlow reviewed all of his and Doctor Sachs' subdural hematomata some years ago, and found that most of them had been relieved by the simpler procedure. Only rarely was it necessary to turn down a flap.

Dr. Ira Cohen (New York) said that if one accepts as a definition of hematoma a collection of blood or clots in the tissues of the body or closed spaces, then it would seem justifiable to group the acute collections of blood in the subdural space and the chronic subdural hematomata in one discussion. It may have the advantage of calling to mind or emphasizing that such a collection or a chronic subdural hematoma—space-occupying lesions in the subdural space—are surgical problems and should be handled surgically. Doctor Browder more than hinted at the fact that although they are all collections of blood in the subdural space, clinically there is a real difference between a so-called acute hematoma—which Doctor Cohen prefers to call a collection of blood in the subdural space—and a chronic hematoma. There is a difference clinically, because in the acute cases there is no question of the close connection between the trauma and the lesion. Moreover, in the acute case the differential diagnosis, as brought out by Doctor Browder, between the responsibility of the hematoma, of the underlying brain lesion, or the brain edema, for the dominant part of the picture, is not an easy one. On the other hand, the chronic subdural hematoma has a different clinical picture and these hematomata present themselves, in Doctor Cohen's experience, in four groups:

In the first group, the patients refer to a trauma received some weeks or months previously, a slight trauma (in some cases so slight as that of a grandmother who has been hit on the bridge of the nose by a grandchild held in her lap) in contradistinction to the severe trauma in the acute collections. These patients connect their symptoms—their headache, or whatever their complaints are—with this remote trauma, and one realizes the connection.

In the second group, the patient often enters the hospital in stupor or semi-

stupor, most often without a history of trauma, and for the time being is regarded as a cerebrovascular accident.

In the third group, one encounters a picture practically akin to that of a brain tumor. A history of trauma is sometimes obtained preoperatively, but usually not until after the operation, and such patients are regarded as having brain tumors until the operation, or in an attempt at air studies an hematoma is found in the subdural space.

The fourth group is practically made up of patients with purely mental symptoms, without a history of trauma. The patient comes in with memory or personality changes, and with almost no sign of organic disease. Here again, an hematoma is diagnosed or thought of only when bur-holes are made for air studies.

As to increase in size of the hematoma, especially chronic hematomas, Doctor Browder did say that he felt that Doctor Gardner's theory is correct. He also referred to Dandy's remarks on edema being the cause of the presenting symptoms. Doctor Cohen said he had no doubt that the hematoma increases in size by osmosis, as Gardner stated, but he also felt that in many cases the final symptoms are due to edema. In one group of hematomata, at operation, the hematoma may be removed and the brain not expand. Certainly, the brain is not the seat of edema in such an instance. On the other hand, when one punctures the outer membrane of hematomata the fluid will squirt out of the needle and Doctor Cohen felt that such a case is one where the pressure is exerted by the intrahematoma pressure. In another group, when the needle is introduced the fluid drops out or has to be aspirated. It is hard to believe that the semistupor of such a patient can be caused by the intrahematoma pressure. Therefore, in those cases one may very well be dealing with an edema of the brain.

Dr. E. Jefferson Browder (Brooklyn) thanked Doctor Cohen for having clarified some of the statements made in the presentation. The illustrative encephalograms that were presented, showing progressive increase in the shift of the ventricular system associated with subdural hematoma, were typical of the findings by repeated air studies in seven other cases. Whether or not this progressive shift of the ventricles is the result of edema of the brain or an increase in the size of the subdural collection, cannot be stated with certainty. All subdural collections are not in a fluid state. Some are encountered as solid as a meningioma. It seems difficult to postulate any theoretical explanation that would meet all requirements in instances in which such a solid hematoma is present for several months without producing symptoms and then, over a period of a few days, causes drowsiness followed by stupor and hemiplegia. Doctor Browder said he could not believe that an organized mass of this type can be augmented by an influx of fluid. An attempt was made, in his presentation, to show that there are many types of subdural collections. On, say the fifth day after injury, one may encounter solid clots; orange-tinted fluid; black, tarry fluid blood; thin, dark brown substance, *etc.* Possibly a dozen different types have been observed. It seems that many of the fluid hematomata increase in size by osmosis, but the organized clots are seldom if ever altered in this manner.

Doctor Elsberg discussed the question of operative approach and method of evacuation of the subdural collections. In some cases the fluid hematoma may be evacuated through one, or, if desired, several bur-holes in the skull, whereas solid clots, as well as some fluid collections, require a small bone flap. At the present time Doctor Browder is using small bone flaps much more frequently than formerly and is in entire agreement with Doctor Elsberg's

statement that subdural hematomata can be more adequately handled through a large cranial opening than by washing out the collection through a bur-opening.

Chronic subdural hematomata, in Doctor Browder's opinion, represent the late phase of the acute hematoma. He has encountered subdural collections from two hours to two years following injury. Those included in the present study were disclosed at operation or at autopsy within three months of injury, most of them within one month.

Doctor Browder said that he had presented the subject as objectively as possible, an attempt being made to portray the problem of head injury complicated by subdural hematoma as it has presented itself in a large city hospital. The 143 cases mentioned occurred in 10,265 admissions, or approximately 2 per cent. Munro has reported a much higher percentage from the Boston City Hospital. In Doctor Browder's series, all instances of laceration of the brain with a thin layer of blood over the site of laceration were excluded, although these are, in the true sense, subdural hematomata.

EXTRADURAL HEMORRHAGE

A STUDY OF FORTY-FOUR CASES

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EXTRADURAL HEMORRHAGE is a dramatic and theoretically well-recognized traumatic lesion of the cranium. Much has been written about it in both early and recent literature. However, after reviewing the reported cases, it has been our feeling that we need make no excuse for bringing the problem forward again. Most of the teaching in medical schools and in the standard text-books of general surgery is misleading or, at the best, cursory. The so-called classical picture, with its initial unconsciousness, lucid interval and secondary period of unconsciousness plus clear spinal fluid under elevated pressure, is so rare as to be the exception rather than the rule. This classical picture has been the more firmly entrenched because some authorities, both neurosurgical and pathologic, have insisted that the bleeding is always arterial. We feel definitely that, in a certain portion of the cases, the source of the extradural bleeding is venous in origin. These facts have also been recognized by other authors.

Our series of 44 cases is somewhat larger than any group heretofore reported from one clinic. It seems to us that certain very definite conclusions may be drawn from an analysis of the results of the fairly standardized method of treatment that we have used over a number of years.

Hippocrates recommended that the cranium be perforated when injuries might be followed by serious consequences such as the extravasation of blood. Celsus advised waiting until untoward symptoms appeared before operating. Since then, many articles have been written on this subject. The more important authors are listed in the references.[1–8] The classical work on extradural hemorrhage, however, is that of W. H. A. Jacobson,[9] written in 1885. Little has been added to the picture since this appeared. He thoroughly analyzed 70 cases; 27 from Guy's Hospital and 43 from the English literature. Any report on this subject must refer frequently to his excellent clinical descriptions. Since that time, several papers reporting the clinical findings and treatment of small groups of cases have appeared annually. In 1938, Pringle[10] published what appeared to be another large series. This was a review of 71 cases of traumatic meningeal hemorrhage. However, in analyzing these cases only 23 can be considered as true extradural hemorrhages, the others being subdural hematomata.

In reviewing the literature, several things stand out: First, many of the early authors were aware of the rarity of the so-called classical picture. Second, not a few of the men writing on this subject realized the probability of venous bleeding as a source of the clot in some of their cases. Finally, there

Submitted for publication July 13, 1940.

has been no large series of cases reported previously by a single clinic in which a well-standardized method of treatment was used.

Incidence.—Extradural hemorrhages are by no means a common complication of a blow on the head. This is illustrated by the fact that in over 1,200 head injuries treated on the Neurosurgical Service of the Boston City Hospital from 1932–1939, only 44 or about 3 per cent showed extradural hematomata. LeCount and Apfelbach[11] report a study of 504 cases that had fractures of the skull discovered at autopsy. In their series, 19 per cent showed extradural hemorrhage which produced appreciable compression of the brain. Moody[12] studied 908 cases of proven fracture of the skull and found 100 instances of extradural hemorrhage (9 per cent).

Etiology and Pathogenesis.—The immediate cause of a traumatic extradural hematoma is, of course, a blow on the head, which may or may not leave external evidence of violence.

The common assumption is that extradural hematomata are always caused by a rupture of the middle meningeal artery or one of its larger branches. This belief has been inculcated by certain authoritative statements to the effect that arterial, and only arterial, bleeding was capable of stripping the dura from the bone. We feel sure that in certain instances the source of the bleeding is venous, either from a great venous sinus or one of the smaller veins. Wood Jones,[13, 14] in two excellent papers, has proven, beyond a doubt, that the grooves in the skull usually believed to be due to the pulsating arteries, are for the most part produced by the veins that accompany these arteries. His convincing discussion will not be elaborated upon here. However, in 1911, anatomists had entirely accepted his findings, although most surgeons are still not aware of this anatomic fact. Wood Jones not only made purely anatomic studies but by injection methods, in three cases in which death had occurred from massive extradural hemorrhage, proved that the venous sinuses around the arteries were torn while the arteries themselves were intact. Verbrugghen[15] has recently reviewed and reiterated the findings of Wood Jones and has reproduced one of the latter's graphic illustrations. In the majority of cases where the bleeding point was definitely observed it has been arterial, but in a smaller number the bleeding was seen to come from one of the great venous sinuses or a tributary vein. LeCount and Apfelbach say that in their series the bleeding was attributable to the anterior branch of the middle meningeal artery in 49 cases and to the posterior branch in 44 cases. They also found three instances in which the bleeding was from a laceration of the superior longitudinal sinus, and eight in which the bleeding was considered to have originated from the lateral sinus. Erichson,[7] Jacobson,[9] and Verbrugghen[15] also record instances of venous bleeding as the source of extradural clots. McKenzie[16] stresses the fact that the bleeding is not always arterial in origin; and speaks of three cerebellar clots. One of these was found at operation. They were caused by torn lateral sinuses. Our series, likewise, includes one cerebellar extradural hematoma. This was found at autopsy, the source of the bleeding being from the lateral sinus.

In our 44 cases, the source of the bleeding was definitely mentioned in

37 instances (84 per cent). In 26 (70 per cent) the bleeding was described as from a portion of the middle meningeal artery. However, it must be mentioned that if the contentions of Wood Jones and others are correct, it is probable that even in certain cases in which the middle meningeal artery was assumed to have been torn, the bleeding, especially if it had not been furious, might have been from the surrounding venous channels. In the 26 cases in which the middle meningeal was said to have been torn, there was a marked variation in the description of the difficulty of controlling the bleeding, and also in the length of the lucid interval, as compared to those with a known venous source for the hemorrhage.

In ten cases in our series there was definite mention of a venous, and only a venous, origin for the bleeding. In seven, the source was demonstrated to have been one of the lateral sinuses. In three, the bleeding was found to have originated from a rent in the sagittal sinus or from one of its large tributary veins.

Thus, a review of the literature and a study of our own experience indicates that the source of extradural bleeding is usually but not always a rupture of the middle meningeal artery or one of its branches. Venous bleeding as a source for the clot has been neglected in discussions of the etiology and pathogenesis of extradural hematoma. To thoroughly understand the clinical and therapeutic problems related to extradural hemorrhages one must be aware of this latter possibility.

TABLE I

SUMMARY OF SYMPTOMS IN 44 CASES OF EXTRADURAL HEMORRHAGE

Finding	Times Mentioned	Contra-lateral	Ipsilateral	Bilateral	Remarks
Hemiplegia	25	22	3	—	
Facial weakness	13	11	2	—	2 ipsilateral, peripheral type
Babinski	34	10	1	23	
Spasticity or rigidity of extremities	10	4	3	3	3 spastic quadriplegias
Abdominal reflexes	9	Absent	Absent	Absent	
		5	1	3	
Deep tendon reflexes	18	Increased	Increased		Absent in 5
		12	1		
Papilledema*	4			4	Interval between injury and observation: 4, 5, 7, and 11 days
Sensory changes	2	2			
Nuchal rigidity	5				
Aphasia	4				All cases showed left-sided clots
Dysarthria	2				
Convulsions	3				1 generalized 2 jacksonian
Clonus (ankle)	2	1		1	
Absent corneal reflexes	1	1			
Astereognosis	1	1			
Diminished hearing	1	1			
Ptosis of eyelid	1	1			
Kernig and Brudzinski	1				
Divergent strabismus	1				

* McKenzie mentioned questionable disk changes in five cases, one of which he believed appeared within 24 hours.

Diagnosis.—(Table I.) Our case histories were frequently inadequate because many of the patients were unconscious when first found and no reliable story could be obtained. The cause of injury was, therefore, indefinite in the great majority of cases. However, there were only three or four in which the injury could be considered as slight. Most of the known causes were automobile accidents, assaults and falls. It has been impossible to decide from our histories which cases had sustained a general and unlocalized head injury and which had received a local blow to the temporal region.

In 23 of the 44 cases, some mention of the ingestion of alcohol was made. We are well aware of the inaccuracy of such statements as "odor of alcohol," and this finding is merely mentioned as one of the probable factors in confusing the diagnosis.

Those who write of the classical picture of extradural hematoma stress the importance of a "lucid interval." There are many reasons why this may be missing or camouflaged. Alcohol, concomitant brain injury and the amount and type of bleeding all may play a part. In our series, 21 or 40.7 per cent, of the cases showed a fairly definite lucid interval. The most prolonged was an interval of 16 days while the shortest was one and one-half hours. The average was slightly longer than three days, the mean being 48 hours. These latter statistics are very much the same as those of McKenzie.[16] Thus, we may say that in more than half the cases, no history of a "lucid interval" was obtainable.

The age of the patient was definitely mentioned in 38 of our 44 cases. The average was 36 years; the youngest patient being eight and the oldest 74. Table II shows the distribution. It is clear that this condition is rare under ten and uncommon beyond age 50. All but one of our cases were males.

TABLE II

AGE DISTRIBUTION

Age	Number of Cases
1–10	1
10–20	7
20–30	6
30–40	9
40–50	7
50–60	5
60–70	2
70–80	1

The site of the clot was mentioned in 43 cases. Twenty-six were right-sided and 15 left. One was bilateral and one occurred in the left posterior fossa.

The neurologic status of the extremities has been considered important in the diagnosis of extradural hematoma. However, it is our impression that the neurologic findings on any one examination are not as important as the shifting or changing of neurologic signs and cannot, in any event, replace an adequate history. In our series, a definite mention of unilateral weakness of the extremities was made in 25 instances. In 22, it was contralateral to the

clot while in the remaining three the weakness was ipsilateral. Thus, in 12 per cent of the instances in which a unilateral hemiparesis was present it was of no localizing value.

Little mention is made in the literature of facial weakness. In our series we found it mentioned on 13 occasions. It was contralateral to the lesion in 11 instances and ipsilateral in the other two. Both of the latter were specifically described as having the peripheral type of facial weakness, while the former were frequently referred to as of the central type. Thus, it is probably fair to assume that the two instances of ipsilateral facial weakness were due to local damage to the facial canal in the temporal bone.

Babinski's sign was present in 34 cases. It was bilateral in 23, contralateral in ten, and ipsilateral in one. It seems obvious that this sign is of no great localizing value in these cases.

Much has been written about the pupillary changes in extradural hematomata and certain authors lay a great deal of stress on the localizing value of such changes. The so-called Hutchinson's pupil, or a dilated and fixed pupil on the side of the lesion, has been considered important since Hutchinson's[6] original description in 1867. In our series, definite mention of the state of the pupils was found in 37 instances. In 18 (48 per cent) the ipsilateral and in five (13 per cent) the contralateral pupil was dilated. In 13 cases (35 per cent) there was a definite statement that the pupils were normal and equal. In the single instance of a bilateral extradural hematoma, the pupils were first equal after which the right became greater than the left. We may conclude that the unilateral, dilated, fixed pupil (Hutchinson) is by no means as common an occurrence as has been frequently stated. However, when present, it is probably ipsilateral in respect to the clot.

We are well aware of the difficulty in estimating the state of consciousness of an individual, and have already mentioned some of the extraneous factors that may play a part in the picture. Some mention of this symptom and its severity at the time these patients were admitted to the Neurosurgical Service was made in 42 of our 44 cases. In 21 cases (50 per cent) the terms "unconscious," "deeply unconscious," "coma" or "deep stupor" were used. In 15 cases (35 per cent) such terms as "drowsy," "stuporous" or "semi-stuporous" were used. The remaining six cases were described in the following terms: "Conscious but incoherent"; "amnesia for the accident but conscious"; "alert, oriented but no memory of the accident"; "uncooperative but oriented"; "irrational, resistive and restless"; "semiconscious but responds." In relation to Pringle's[10] statement about prognosis, it is interesting to note that of our 21 cases definitely in coma, 15 (71 per cent) died. In the group of 15 cases described as being drowsy or stuporous on admission, seven cases (46 per cent) died, while in the six cases that were conscious on admission, there was only one fatality.

Pringle lays special stress upon the importance of local hematomata, and bleeding from one ear. He also speaks at some length about percussion of the head over the suspicious area. We have no data on the value of this

procedure. In our series, bleeding from the ear was mentioned on eight occasions. It was ipsilateral in six, contralateral in one, and bilateral in one. Other signs of trauma such as the so-called Battle's sign, scalp hematomata, localized tenderness, ecchymosis of the eyes, and abrasions and lacerations of the scalp, were mentioned in 28 cases. In 23 of these, the signs were ipsilateral, in four contralateral, and in one bilateral. Thus, in over 82 per cent of the cases in which these factors were mentioned they were of definite localizing value.

Cerebrospinal Fluid.—There has been much argument about the value and danger of lumbar puncture in head injuries in general. We believe that the danger is minimal and that the information obtained is not only essential but of a sort that far outweighs any possible risk. Except for the intracranial pressure, however, the cerebrospinal fluid findings are of no value in making the diagnosis of extradural hematoma. They do no more than indicate the amount and type of brain damage. This is important, to be sure, as it is on this complication that the presence and length of the "lucid interval" depends. Even the pressure readings, however, are not entirely reliable as they may be falsified because of toxic dehydration or surgical shock.

Our records mentioned preoperative spinal fluid findings in 38 cases. For purposes of the analysis of the cerebrospinal fluid pressure readings, the first puncture that was made on the Neurosurgical Service is the one we have used for our statistical studies. This was chosen because in several instances, earlier punctures made by the General Surgical and Medical Services failed to give accurate pressure readings. We are aware that this arbitrary use of the first "neurosurgical" puncture may alter slightly the composite picture, for in certain instances a primarily elevated pressure may have been lowered by frequent earlier punctures, while in others an initial low pressure, due to surgical shock or dehydration, may have been raised by treatment. The initial pressure was measured in 36 cases. The average reading was 216 Mm. of water (cerebrospinal fluid). The highest pressure recorded was 500 and the lowest 50 Mm. of water. There were 12 cases (33 per cent) with an initial pressure of 150 or below, while 38 per cent were below 200 Mm. of water. Table III shows the variation in pressure:

TABLE III

PRESSURE RANGE OF CEREBROSPINAL FLUID

Pressure in Mm. Water	No. of Cases	Per Cent
50–100	2	5
100–150	10	28
150–200	2	5
200–300	11	30
300–400	5	13
400–500	6	16

It is obvious that in a third of the cases there was an apparently normal spinal fluid pressure but, without associated data as to the patient's pulse pressure and fluid metabolism, such statistics are valueless.

The character and appearance of the fluid was noted in 37 instances. The following descriptive terms were used: Clear; xanthochromic; pink; slightly bloody; and bloody. Only rarely were any accurate cell counts made. In 19 cases (51 per cent) the fluid was described as either grossly bloody or bloody. Ten cases (27 per cent) showed a fluid described as pink. In five cases (13 per cent), the fluid was xanthochromic, while in three cases (8 per cent) the fluid was clear. It is thus apparent that in 92 per cent of our patients who suffered from an extradural hematoma the associated brain injury was at least as severe as a contusion.

In attempting to correlate the spinal fluid findings with the mortality, it is possible to draw only general conclusions. This is because of the influence of such factors as surgical shock, dehydration, the degree of brain injury, the length of the preoperative period, the technical skill of the operator, the hospital operating room equipment, *etc.* In general, it can be said that patients with complicating severe brain injuries, early, excessively high cerebrospinal fluid pressures, severe toxic dehydration, and any associated shock or hemorrhage do very badly and have a poor chance of survival. Thirty-six per cent of the fatal cases had a preoperative pressure of over 300 Mm. of water, while in the group of recoveries only 21 per cent had pressures above this level. In considering the appearance of the spinal fluid, it appears that 90 per cent of the fatalities showed either bloody or pink fluid, while only 62 per cent of the recoveries had fluids of this character. This discrepancy is even more marked if we use only those cases in which the fluid was described as grossly bloody. Sixty-six per cent of the fatalities showed gross blood, while this finding was present in only 37 per cent of the recoveries. Thus, the extent of the brain damage as measured by the appearance of the cerebrospinal fluid plays a more important rôle in the prognosis than does the increase in cerebrospinal fluid pressure.

Roentgenographic Findings.—It has been our experience that the suspicion of the presence of a cerebral extradural hematoma is one of the two absolute indications for roentgenologic examination. It should be realized, however, that the so-called standard roentgenograms are always unnecessary and often inadequate. This particular examination is made only for the purpose of demonstrating a fracture line in relation to either the middle meningeal artery or to one of the large venous sinuses. No more than one film will be necessary but this film must show not only the fracture but also the groove of the artery in the bone and the shadows of the suspected sinuses. To enable the roentgenologist to make such a film, the surgeon must indicate the side of the head that is to be taken, accept the responsibility for the necessary transportation and handling of the patient, and be prepared to provide enough assistance to ensure absolute immobility of the patient's head during the single exposure. Under these conditions, he can accept a negative film as being as truly negative as is possible. In such circumstances, he will revise his estimate of the diagnostic significance of his other findings, whereas with a positive film—that is, one in which a fracture can be shown to cross any part of the artery

or the sinuses—the balance will be weighted in favor of a positive diagnosis of clot and therefore of immediate operative interference. Although the demonstration of a fracture has no prognostic significance in these cases, its diagnostic importance cannot be overrated. We have yet to see an extradural hematoma in the absence of a fracture of the bone in the immediate vicinity of the bleeding point—providing an adequate search for the latter has been made.

In the series under consideration, preoperative skull roentgenograms were taken in 18 cases (40 per cent). In three instances, the reports were negative for fracture and in each of these a fracture was found either at operation or at autopsy. Operation or autopsy also confirmed the roentgenographic findings in the remaining 15 cases. Of the 26 cases in which no roentgenograms were taken, 16 showed a definite fracture either at operation or autopsy. In ten, no fracture was demonstrated. Six of these were autopsied and four operated upon. It is our opinion that extradural hematomata probably do not occur in the absence of fracture.

Differential Diagnosis.—Detailed analysis of the cases in this study bears out the statement that one of us (D. M.[17]) has repeatedly stressed in the past: The clinical picture of extradural hemorrhage is extremely variable and cannot be depended upon from a diagnostic point of view. Even with the associated aids of history, roentgenographic and cerebrospinal fluid findings, this diagnosis remains one of the most difficult in the whole field of craniocerebral injuries. The impression of simplicity of diagnosis that one gains from the usual text-book description is very dangerous and misleading. The so-called classical picture is extremely rare.

Since Jacobson's article in 1885, little has been added to the list of conditions that may be confused with extradural hematoma. They include cerebral lacerations and contusions; localized cerebral edema; subdural hematoma; depressed skull fracture; and intracerebral hematoma (traumatic or spontaneous). Any of the preceding conditions may be accompanied by an extradural hematoma, however, which, when added to the underlying brain damage, tips the scales in favor of a fatal outcome. The problem of separating the former from the latter is frequently made much more difficult by such added complicating factors as intoxication from alcohol or other drugs, surgical shock and toxic dehydration, all of which alter the clinical and cerebrospinal fluid picture. Thus, it is obvious that in many instances the final diagnosis can only be made after a diagnostic exploratory trephination. This can be performed under local anesthesia with but little risk to the patient. It is justified because when treating a desperate situation such as an extradural hematoma and, moreover, one in which the unoperated mortality is 100 per cent, the risk to which a patient without a clot is thus exposed shrinks into insignificance in comparison with the increase in therapeutic efficiency made available to the individual who has been so unfortunate as to be suffering from extradural bleeding.

Treatment.—As soon as the diagnosis of extradural hemorrhage *cannot be disproved,* the only treatment is an immediate emergency operative procedure.

It is important that the surgeon who undertakes to operate upon these cases be well-prepared both as to mechanical equipment and skilled help. He must have available an adequate suction apparatus and a minimal supply of cranial surgical instruments. A reliable method of administering therapy intravenously must be set up at once by a special team who will have this as their sole responsibility. At least two and usually more compatible blood donors must be available as transfusions are always necessary to treat shock and to replace lost blood. They will have to be given through the intravenous set-up. Directness and speed of action are the deciding factors in bringing these cases to a successful conclusion. These preliminary precautions must be taken in every such case. If the patient is in a hospital that lacks adequate operative equipment or personnel, he should be moved at the earliest possible moment to one that has such equipment. The risk of moving even the sickest patient, is minimal when compared with the danger of operating upon an extradural hemorrhage without adequate equipment and help.

The operation can usually be performed with only local anesthesia, but if the patient is resistive and restless a few centimeters of sodium pentothal intravenously will give adequate relaxation. The ideal approach is the usual subtemporal route. This should be modified to meet individual requirements. After the bone has been removed widely enough to give adequate exposure, the clot should be evacuated as completely as possible by suction. The bleeding point must be adequately controlled. This implies technical exactness and certain occlusion of the bleeding vessel. Arteries should be clipped or tied with silk, and venous bleeding points controlled by the careful placing of adequate muscle stamps. Attempts to stop bleeding in these cases with electrocoagulation is dangerous and will usually lead to recurrence of the clot. If the artery has torn close to its entrance to the skull, the external carotid artery should be tied in the neck if there is any doubt about recurrence of the bleeding because of a slipped ligature. Having safely checked the bleeding, the dura should be opened widely in order to give an adequate decompression. We consider this latter procedure important as a protection against the untoward effects of the usual postoperative edema. The wound should be drained with one or two rubber drains led out through the bottom of the incision. These are adjusted according to the size of the cavity that remains after the clot has been removed. One may be placed inside the dura under the temporal lobe and one in the extradural cavity. They provide drainage for whatever oozing there may be after closure and should be removed in 24 hours. On occasion, quite large amounts of bone may have to be removed to adequately control bleeding, especially when it is coming from a lateral sinus. We feel that the absence of this bone is of no importance in the light of saving the patient's life, and especially so if it is removed in an area in which the temporal muscle can be employed as a covering for the opening.

The postoperative care of the patient is extremely important. He must be followed very closely and the so-called malignant postoperative edema combated with adequate dehydration and lumbar punctures. Coma may persist

for several days postoperatively. Every effort must be made to prevent pulmonary congestion and resulting pneumonia. Adequate fluids must be administered. Not uncommon complications of extradural clots are certain midbrain signs which are probably due to the gross shifting of the entire intracranial contents. Perhaps the most dreaded of these is hyperthermia. In the treatment of this condition we have used frequent tepid sponges with remarkable success. Tepid sponges seem to cause dilatation of the peripheral vessels and facilitate heat loss more readily than the alcohol and ice water sponges previously employed. Removal of all covers, playing an electric fan on the patient while still wet, and cold water or shaved ice enemata have also helped. Erickson[18] has recently given an excellent summary of the possible pathogenesis and treatment of so-called neurogenic hyperthermia. He stresses the importance of recognizing the condition in its inception by the accompanying tachycardia and hyperpnea and instituting treatment early. In the extradural cases, however, the usual first sign is the excessive and steady rise in temperature.

Mortality and Complications.—The mortality from extradural hematomata has always been very high except for the unbelievably good results of J. Hill[1] in 1772. The figure usually quoted to-day is around 50 per cent. This comes from clinics in which there are well-equipped neurosurgical units. There can be no question but that the general mortality is much higher. Our 44 extradural hematomata show a total or case mortality of 59 per cent, and an operative mortality of 52 per cent.

Thirty-eight (86 per cent) were operated upon. The six unoperated cases all died. Twenty of the operated cases died. Table IV gives the mortality statistics for the years covered in this study.

TABLE IV

MORTALITY

Year	Total Mortality	No. of Cases	No. Operated
1932	66	3	3
1933	50	4	3
1934	66	6	6
1935	66	6	5
1936	75	4	3
1937	37	8	8
1938	60	5	4
1939	62	8	6

In the six cases that died without being operated upon, the mortality was 100 per cent. One died before operation because of uncontrollable hemorrhage from some unknown source in the nasopharynx. We consider this an unavoidable fatality. Two cases died almost immediately after admission to the accident floor and before even the barest preparations could be made for operation. The remaining three cases died because of the delay in operating. In one, difficulty was encountered in obtaining operative permission. Of the other two, one was kept on the General Surgical Service for 36 hours before the condition was recognized and neurosurgical consultation requested, and the other died on the Neurosurgical Service with the incorrect diagnosis of

lacerated brain and dehydration. In one-half of these six cases, the diagnosis of extradural hematoma was made before death, while in the other half either a diagnosis of lacerated brain or subdural hematoma was made. At least half of them could have been saved by earlier diagnosis and the more rapid institution of therapy.

In analyzing the 20 cases that died in spite of surgical intervention, we may immediately dismiss one that died several weeks after the operation from unrelated lobar pneumonia. The other 19 cases have been divided into two groups: In the first group, there were six deaths that could be ascribed to technical errors; and in the second, 13 that were caused either by the brain damage which accompanied the clot or by other complications which caused or contributed to the fatal outcome. Among these complications were pneumonia, myocardial failure and uremia.

The six fatalities in the first group follow: In one case which was explored through frontal bur-holes, the clot was not found. In a second instance, the patient had a compound fracture as well as an extradural hemorrhage, neither of which was diagnosed. Both of these cases were seen in 1932–1933, before we had developed our present standard of technic and therapy. The third case was one in which the diagnosis was made and bilateral exploration undertaken, but the exposure was inadequate and failed to demonstrate a large posteriorly-located clot. There were, also, two cases which developed postoperative meningeal infection. The final case in this group was one in which a recurrent extradural hemorrhage developed. Failure to recognize this complication early enough resulted in a fatality. It is important to be on the watch for recurrent extradural hematomata; on one occasion we had removed such a recurrence with ultimate recovery of the patient. The possibility of recurrent bleeding in extradurals has recently been emphasized by Ellis.[20]

The records of the remaining 13 fatal cases demonstrate that death was traceable to the concomitant brain damage (contusion, laceration, and intracortical clot), which was so severe as to make recovery improbable, or to some extraneous complication which of itself prevented recovery.

An analysis of these mortality statistics warrants the following conclusions: There will probably be about 25 per cent of the cases of extradural hematoma in which either the severity of the accompanying brain damage or the general physical condition of the patient will prevent recovery, even with the most timely and ideal treatment of the clot. In another 15 per cent, recovery would be probable if all possible advantages were taken of our present diagnostic and therapeutic methods. Thus, providing ideally proper care had been given, there would have been a reduction of our case mortality from 59 to 44 per cent.

SUMMARY AND CONCLUSIONS

A series of 44 cases of extradural hemorrhage, seen and treated on the Neurosurgical Service of the Boston City Hospital, between the years 1932–1939, has been reviewed.

A statistical study of the clinical, cerebrospinal fluid, and roentgenologic findings has been presented.

A standardized method of treatment has been outlined.

We believe that the so-called classical picture of extradural hematoma is so rare that it is the exception rather than the rule, in practice. This fact must be more widely recognized if the mortality from this condition is to be reduced.

In the past, the possibility of venous bleeding as a source of extradural clots has been overlooked. Sufficient evidence has now been collected to demonstrate its actuality and to prove its importance.

REFERENCES

[1] Hill, J.: Cases in Surgery, R. Baldwin, Edinburgh, 1772.
[2] Bell, Sir Charles: Surgical Observations, 466–467, Longman, Herst, Rees, Arnie and Brown, London, 1816.
[3] Cock, Edward: Guy's Hospital Rep., 7, 157, 1842.
[4] Hewett, Sir Percy: Holmes' System of Surgery. 2nd Ed., 2, 258, 1870 (New York).
[5] Callender, G. W.: The Anatomy of Brain Shocks. St. Bartholomew's Hosp. Rep., 3, 415–444, 1867.
[6] Hutchinson, Jonathan: Lectures on Compression of the Brain. London Hosp. Rep., 4, 10–55, 1867–1868.
[7] Erichson, John E.: Injuries of the Head. Lancet, 1, 1, 1878.
[8] Gross, Samuel W.: An Examination of the Causes, Diagnosis, and Operative Treatment of Compression of the Brain as Met with in Army Practice. Am. Jour. Med. Sci., 66, 40–74, 1873.
[9] Jacobson, W. H. A.: On Middle Meningeal Hemorrhage. Guy's Hosp. Rep., 43, 147–308, 1885–1886.
[10] Pringle, J. H.: Traumatic Meningeal Hemorrhage; with a Review of 71 Cases. Edinburgh Med. Jour., n.s., 4, 741, 1938.
[11] LeCount, E. R., and Apfelbach, C. W.: Pathologic Anatomy of Traumatic Fractures of the Cranial Bones and Concomitant Brain Injuries. J.A.M.A., 75, 501, 1920.
[12] Moody, W. B.: Traumatic Fracture of the Cranial Bones; Clinical Consideration with Special Reference to Extradural Hemorrhage. J.A.M.A., 74, 511, 1920.
[13] Wood Jones, Frederic: On the Grooves upon the Ossa Parietalia Commonly said to Be Caused by the Arteria Meningea Media. Jour. Anat. and Physiol., 46, 228, 1911–1912.
[14] Wood Jones, Frederic: The Vascular Lesion in Some Cases of Middle Meningeal Hemorrhage. Lancet, 2, 7–12, 1912.
[15] Verbrugghen, A.: Extradural Hemorrhage. Am. Jour. Surg., n.s., 37, 275–290, 1937.
[16] McKenzie, K. G.: Extradural Hemorrhage. Brit. Jour. Surg., 26, 346, 1938.
[17] Munro, Donald: Craniocerebral Injuries. Oxford University Press, New York, 165, 1938.
[18] Erickson, T. C.: Neurogenic Hyperthermia. Brain, 62, 172, 1939.
[19] Ellis, F. F.: Repeated Extradural Hemorrhage. Med. Jour. Australia, 25, No. 1, 262, 1938.

EXTRADURAL VENOUS HEMORRHAGE

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THE RARE OCCURRENCE of extradural venous hemorrhage in comparison with subdural venous hematoma or extradural arterial hemorrhage made us feel that attention should be attracted again to its symptoms and signs.

In patients having extradural hemorrhage, either arterial or venous, a lucid interval of hours to days usually intervenes between the time of the accident and the onset of symptoms of increased intracranial pressure. The accumulation of extradural venous blood is naturally slower than if the blood were arterial, but as Verbruggen[1] stated, it is the blow to the head at the time of the accident that separates the dura from the bone and bleeding occurs into the space thus formed. He felt that it is the shaking of the dura from the bone and its adherence to the overlying skull in the face of an advancing clot that are the principal factors in the length of the lucid interval. The resultant compression of the brain beneath the extravasated blood usually produces contralateral weakness, altered reflexes, jacksonian seizures and other localizing signs. In many instances the pupil is dilated on the side of the lesion. Restlessness followed by drowsiness and other signs of increased intracranial pressure develop, and surgical intervention becomes a life-saving measure.

Postoperative extradural venous hemorrhage is still a serious complication following craniotomy, and if not recognized may be the important factor in producing a fatality after an otherwise satisfactory operation. Dandy[2] and Poppen[3] have recently emphasized certain operative steps in an attempt to prevent such hematomata, but we occasionally are forced to elevate bone flaps and remove extradural venous clots in spite of employing all precautions. Such postoperative hematomata need be only 1 cm. in thickness, and localized beneath the bone flap, to change a conscious, alert patient to a stuporous, unresponsive one.

Diagnosis.—The deep red color of venous hemorrhage found on trephination is the only accurate method of differentiating a tear of the smaller branches of the middle meningeal artery from a tear in the emissary and meningeal veins. Even then, it may be difficult to decide unless one utilizes the maneuver of Verbruggen in which, when an assistant compresses the common carotid artery on the affected side, arterial bleeding stops and venous bleeding increases. This venous bleeding increases because the internal jugular vein is compressed along with the carotid artery.

Submitted for publication August 22, 1940.

Although extradural venous hemorrhage does occur without linear fracture, suspicion of venous hemorrhage is given roentgenographically if a depressed fracture of the skull is near a dural sinus. The location of linear fractures by overlying edema of the scalp, and by roentgenograms, may give a clue as to whether the middle meningeal artery or the veins entering the lateral or longitudinal sinuses have been torn.

Extradural venous hemorrhage is difficult to differentiate from extradural arterial hemorrhage and acute subdural venous hemorrhage.

Carter[4] stated that when one can elicit a history of a blow on the head: a primary loss of consciousness due to concussion, a clear interval with regaining consciousness, and a second loss of consciousness, the burden of proof is on him to rule out an extradural hemorrhage, and such a history is sufficient to warrant a cranial exploration. He related the case of a two-year-old girl with a linear fracture in the parietal region who showed very little in the way of signs following a fall out of a window, until 48 hours later when she became unconscious and showed weakness of one side. A large extradural hemorrhage was found, with bleeding from several veins near the midline of the skull.

McKenzie[5] emphasized the lucid interval as the most valuable diagnostic sign in extradural arterial bleeding, but a prolonged lucid interval of even one or more days was not infrequent and might confuse the diagnosis. Such cases may become critically ill very rapidly. He found that a dilated pupil, roentgenographic evidence of fracture, and paresis were valuable diagnostic and lateralizing signs. The initial clinical evidence of injury to the brain was insignificant in practically all his cases. Failure to operate and delay in operation caused death in six of his 20 cases of extradural hemorrhage, so that he advocated bilateral exploratory bur-holes if there was a reasonable suspicion of the diagnosis, believing it was better to have a negative exploration than an operation carried out too late or not at all.

Verbruggen felt that the typical and characteristic syndrome of extradural hemorrhage was recognized readily and did not present a special problem, but there was a large group of cases in which the diagnosis was extremely difficult because the extradural clot developed while the patient was unconscious from severe cerebral injury or from alcoholism. He emphasized the facts that the lucid interval may be absent and that the test for hemiplegia even in the comatose patient could be made by firm supra-orbital pressure. He felt attention had been too closely focused on the middle meningeal artery, since a number of his cases had extradural venous hemorrhage from tears in the meningeal veins. He also reviewed the important work of the anatomist Wood Jones,[6] who showed that the grooves on the inner surface of the skull, usually considered as due to the pulsating middle meningeal artery, were actually produced by the veins or sinuses which accompany the artery. Verbruggen believed that the best indications for operative interference in a patient unconscious from cerebral damage were deepening coma and the insidious onset of hemiplegia. When in doubt a bur-hole was not dangerous to the patient and determined the presence or absence of an operable condition.

Ricard[7] reported a case and gave an extended discussion of traumatic rupture of the lateral sinus producing extradural hemorrhage.

Voris'[8] case simulated a middle meningeal hemorrhage, but was due to a tear in the lateral sinus.

Kennedy and Wortis[9] reported 72 cases of acute subdural hematoma and 17 cases of acute epidural hemorrhage operated upon within three weeks of the accident. They noted that acute subdural hematoma occurred at all ages, whereas epidural hemorrhage was more apt to occur in young adult and middle-aged individuals. The epidural hemorrhage usually occurred on the side which received the trauma, whereas an acute subdural hematoma was much more likely to be in the nature of a contrecoup phenomenon. Epidural hemorrhages were almost invariably associated with an overlying fracture line crossing the middle meningeal groove or one of the cranial venous sinuses. The lucid interval in cases of epidural hemorrhage was usually of shorter duration. If paresis resulted in cases of epidural hemorrhage it was practically always contralateral. In cases of acute subdural hematoma a resultant paresis was just as apt to be ipsolateral.

Treatment.—The only treatment for extradural hemorrhage, whether of venous or arterial origin, is prompt surgical intervention. When in doubt as to the proper course to follow after an injury to the head and when the condition of the patient remains precarious or does not improve, we have found that the bilateral exploratory bur-holes, made under local anesthesia, have never done harm and generally have been of valuable diagnostic aid in differentiating between increased intracranial pressure from trauma and edema of the brain or from subdural and extradural hemorrhage.

Extradural venous bleeding has been controlled by gauze packs, by enlarging the bur-holes, or by turning down a bone flap to expose the bleeding points and control the hemorrhage with pieces of muscle.

The two cases herewith presented will emphasize some of the difficulties encountered in treating extradural venous hemorrhage.

CASE REPORTS

Case 1.—(E. J. M.). D. L., male, age 21, on the evening of March 24, 1929, fell while trying to board a moving street car and struck his head on the pavement. He was unconscious for approximately 15 minutes. There was no bleeding from the ears, nose or mouth and no laceration of the scalp. Upon regaining consciousness he went home but that same evening he entered the Mission Emergency Hospital, complaining of headache and nausea. Examination after transference to the San Francisco Hospital showed him conscious, rational and cooperative, with a pulse of 68, respirations 20, and blood pressure 136/64. There were no localizing signs or evidence of increased intracranial pressure. The following day he was rather stuporous with a slower pulse and respiration. On the morning of March 26, 1929, the patient was stuporous, the right pupil was dilated, the pulse 60, and respirations 16. A left facial weakness and fairly marked paresis of the left arm and leg had developed. *Clinical Diagnosis:* Extradural hemorrhage on the right side. Operation undertaken at once.

Operation.—A right subtemporal decompression was planned. On trephining the bone, black clotted blood bulged through the opening. About 20 cc. of clotted blood was removed when the opening was enlarged. This was followed immediately by rather severe

bleeding which filled the cavity. The bleeding seemed to come from the transverse and longitudinal sinuses. The middle meningeal artery was tied but this did not decrease the hemorrhage to any appreciable extent. Gauze packing was inserted in the direction of the sinuses which stopped the bleeding. The patient regained consciousness as soon as the extradural hemorrhage was removed. The wound was closed and the patient was returned to his bed in good condition. The weakness of the left face, arm and leg was hardly noticeable but the right pupil was still dilated.

Subsequent Course.—On March 27, 1929, the pupils were equal, there were no localizing signs, and the patient was conscious, rational and quite cooperative. Approximately 18 hours postoperatively the packing was removed. Within a very short time he became extremely restless, then stuporous. The right pupil was dilated, pulse 58, respirations 18, and blood pressure 186/90.

The patient was again taken to the operating room. When the wound was reopened, a large amount of extradural blood was removed and a thin strip of muscle taken from the thigh was placed along the longitudinal and transverse sinuses. Within a very short period of time bleeding stopped and the wound was closed. The following day the patient was greatly improved. He was clear mentally, his pupils were equal, and the blood pressure was 142/82. The only positive sign was a slight right facial weakness, but within a week no positive neurologic findings remained.

Case 2.—(F. L. R.). E. G., male, age 38, referred by Dr. D. Carson, was struck and knocked down about noon, February 17, 1940. He picked himself up and was taken at once to a hospital, where roentgenograms revealed a fractured left ulna. While this examination was being made, two hours after the injury, his speech became incoherent and a roentgenogram of the skull was made which revealed a linear fracture in the left occipital bone extending from behind the mastoid to the vertex. He became stuporous that afternoon and a lumbar puncture revealed slightly blood-tinged fluid under increased pressure. He remained quite drowsy for the next two days although he could be aroused sufficiently to take small amounts of food. The pupils had been dilated with atropine the day of the accident. During this time the neurologic examination was normal.

He was transferred to Stanford Hospital the evening of the third day, at which time he was stuporous. The pupils were still dilated from atropine and the eyegrounds were not remarkable. The reflexes were equal. Dorsal flexion of the left big toe was obtained on plantar stimulation. Sensory examination could not be made because of the coma. Examination of the roentgenograms taken the day of the injury showed the calcified pineal body displaced a little to the right. New roentgenograms, examined immediately, revealed the pineal body displaced 0.5 cm. to the right and downward. *Clinical Diagnosis:* Probable subdural hematoma. Immediate operation was undertaken.

Operation.—February 20, 1940: Under local anesthesia, bilateral bur-holes were made in the parietal region. A tense brain was seen on the right side but on the left side, as soon as the bone was perforated, old, dark blood escaped, estimated to be four to five ounces. The trephine opening was enlarged, which increased the venous bleeding until sinuses between bone and dura were coagulated. Another bur-hole in the left temporal region revealed no blood. With the release of the extradural blood the patient regained consciousness. Intravenous normal saline, 2,300 cc., was administered slowly to keep the brain and dura tight against the bone. At the end of the operation a transfusion was given.

Subsequent Course.—The patient did well that night but was drowsy the next morning, and did not cooperate well during the neurologic examination.

Two days after operation, on February 22, 1940, he was again stuporous. On reopening the left temporal bur-hole no blood was found. A new trephine opening was made over the left occipital region and dark clotted blood was found to have separated the dura 2 cm. from the skull. Another bur-hole further forward and near the vertex exposed the edge of the clot. A bone flap was then turned down over the left parieto-

occipital region and about four ounces of clotted blood removed. The dura was found separated back to the tentorium and across the vertex, with a number of vigorously bleeding points from the longitudinal sinus. Temporary dry gauze packing decreased the bleeding sufficiently to permit waxing the inner table and controlling the bleeding from the longitudinal sinus with strips of muscle, obtained from the exposed temporal muscle. In the meantime intravenous normal saline had been started and within an hour the depressed brain and dura had expanded to touch the skull. The patient became conscious and started taking fluids. Another blood transfusion was given at the end of this operation.

The next day he was drowsy, but on February 24, 1940, he was alert and cooperated during examination, which revealed a right-sided anesthesia and a right homonymous hemianopsia. He was hesitant in finding proper words. March 3, two weeks after the injury, the positive neurologic findings were no longer present. He returned home on March 13, and resumed work June 1, 1940.

CONCLUSIONS

Extradural hemorrhage requires prompt diagnosis and surgical treatment.

Extradural venous hemorrhage was considered of rare occurrence.

A considerable number of extradural hemorrhages, believed to arise from a torn middle meningeal artery, were caused by torn meningeal veins or sinuses.

A lucid interval followed by stupor, dilated pupil, roentgenographic evidence of fracture, and paresis, are valuable diagnostic signs of extradural hemorrhage.

The only accurate method of differentiating between extradural arterial and extradural venous hemorrhage is the color and source of the blood found on trephination.

Occasionally, exploratory bur-holes, made under local anesthesia, are necessary to differentiate between increased intracranial pressure from trauma and edema of the brain on the one hand, and from subdural and extradural hemorrhage on the other hand.

REFERENCES

[1] Verbruggen, A.: Extradural Hemorrhage. Am. Jour. Surg., 37, 275, August, 1937.
[2] Dandy, W. E.: Lewis' Practice of Surgery. 12, 171, 1932. W. F. Prior Co., Hagerstown, Md.
[3] Poppen, J. L.: Prevention of Postoperative Extradural Hematoma. Arch. Neurol. Psychiat., 34, 1068, November, 1938.
[4] Carter, B. N.: Extradural Hemorrhage and Chronic Subdural Hematoma. Jour. Med., 13, 305, August, 1932.
[5] McKenzie, K. G.: Extradural Hemorrhage. Brit. Jour. Surg., 26, 346, October, 1938.
[6] Jones, F. W.: On the Grooves Upon the Ossa Parietalia Commonly Said to Be Caused by the Arteria Meningea Media. Jour. Anat. Physiol., 46, 228, April, 1912.
[7] Ricard, A.: Des Ruptures Traumatiques du Sinus Lateral. Lyon chir., 26, 476, August–September, 1929.
[8] Voris, H. C.: Extradural Hemorrhage from a Tear in the Lateral Sinus Simulating Middle Meningeal Hemorrhage: Report of a Case. Arch. Neurol. Psychiat., 43, 609, March, 1940.
[9] Kennedy, F., and Wortis, H.: "Acute" Subdural Hematoma and Acute Epidural Hemorrhage. Surg., Gynec., and Obstet., 63, 732, December, 1936.

THE SURGICAL TREATMENT, BY DRAINAGE, OF SUBACUTE AND CHRONIC PUTRID ABSCESS OF THE LUNG*

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THE VOLUMINOUS literature concerned with chronic abscess of the lung indicates the attention which has been paid to this condition. Unfortunately, it also discloses a general lack of agreement on a plan of management and an absence of any uniformity of view in regard to treatment. Indeed, the reported poor results of operation are so nearly identical with the reported poor results of nonoperative treatment that justifiable confusion exists at the present time as to choice of procedure. The purpose of this communication is to set forth certain principles in the selection of operative cases and in operative treatment, in the hope that some aspects of the surgical management of the disease may be clarified.

It is our opinion that the difficult problem of chronic abscess of the lung should no longer exist. We have maintained that abscess of the lung, in its acute stage, is a surgical disease, that it should not be permitted to pass into the chronic stage, and have demonstrated that the results of operation in the acute stage, both as to life and function, are excellent. For purposes of comparison with the results of operation for subacute and chronic abscess, our results of operation for acute abscess, which have been discussed elsewhere,[3 to 9] should be mentioned. To date, 104 patients have been operated upon for acute putrid abscess, with four deaths. The patients who recovered are well, and the wounds are healed in almost all cases, with the exception of four recently operated upon. All of the latter are progressing satisfactorily. However, there is as yet no general acceptance of our views on early operation, and we assume that chronic pulmonary abscess will remain a problem for years to come.

Definition.—The term "chronic putrid abscess of the lung," as employed in this paper, should be clearly defined in order to avoid confusion referable to the inclusion of heterogeneous cases. Consideration, therefore, will not be given to nonputrid chronic pulmonary abscess, pulmonary abscess due to extension of infection from neighboring regions, pulmonary abscess due to aspirated foreign body, and pulmonary abscess secondary to wounds, carcinoma, or tuberculosis. Putrid pulmonary suppuration secondary to bronchiectasis is also excluded. Thus, there remains for discussion a lesion which

* Read before the New York Surgical Society, January 24, 1940. Submitted for publication December 21, 1939.

may be termed "primary" putrid abscess of the lung, ascribed by us to known or assumed aspiration.

Shall subacute and chronic abscess be defined from the point of view of time or of pathology? In our presentations of the subject of acute putrid abscess of the lung, we pointed out that the majority of lesions remained single and uncomplicated during the first six weeks of the disease. Accordingly, we defined acute abscess rather empirically as one of less than six weeks' duration. Occasionally spillover bronchopneumonia and multiloculation occurred during this period. However, multiloculation, spillover bronchopneumonia, gangrenous extension, the formation of additional abscesses, and beginning surrounding fibrosis occurred more frequently in the second stage of the disease. These features, although not regularly present, nevertheless characterize "subacute abscess of the lung" which we have designated rather arbitrarily as extending over a period of six weeks (from the beginning of the seventh week to the end of the twelfth week). All abscesses of more than 12 weeks' duration are termed "chronic." Chronic putrid abscess of the lung presents the features of subacute abscess with the addition of well established surrounding pulmonary fibrosis and bronchiectasis. It will be shown in a succeeding paragraph, however, that the pathology of chronic pulmonary abscess may present considerable variation.

Comments on Some Current Methods of Treatment.—So-called conservative methods of treatment, as employed in cases of acute abscess of the lung, have been applied to subacute and chronic abscess. As a result, there is to be found, even in recent literature, the recommendation of drug treatment, fresh air and rest, postural drainage, bronchoscopic treatment, pneumothorax, and thoracoplasty. We are of the opinion that such methods offer little likelihood of cure of pulmonary abscess. Assuming their possible curative effect in the acute stage, little more than some measure of relief can be anticipated from their employment in subacute and more particularly in chronic abscess. In addition, there is grave risk in the application of pneumothorax or thoracoplasty.

The only method of treatment to be discussed in this paper is the time-honored one of surgical drainage. That it is far from ideal is very generally recognized. The reported operative mortality is high, ranging from 25 to 50 per cent in different statistics. Furthermore, reported results in patients who survive are by no means uniformly good. The analysis of 47 operative cases by Cutler and Gross[1] in 1936, is of interest in this connection. Sixteen patients were cured, six improved, three unimproved, and 22 died. In fact, these authors reported better results and lower mortality (29 per cent) in 38 patients who received medical treatment. Thus, the question to be answered is whether surgical drainage, which is in general use at the present time in the treatment of subacute and chronic abscess, is a justifiable procedure. We believe that the answer lies in the correct selection of cases, to be followed by precise localization of the lesion, and the establishment of drainage by means of an adequate unroofing operation. The question of selection of

suitable cases for drainage will be discussed under the headings of subacute and chronic abscess of the lung.

Subacute Putrid Abscess.—From the viewpoint of pathology, subacute putrid abscess may present features which are common either to acute or chronic pulmonary abscess. Thus, the cases fall essentially into two groups. In the first group the features resemble those of acute abscess because the lesion is essentially localized. Although the cavity frequently is multilocular, there is only a limited tendency for the spread of pulmonary infiltration beyond its original site. In the second group of cases, the lesion resembles chronic abscess insofar as there is a tendency for the pneumonitis to spread by direct extension into adjacent areas of the lung and by the mechanism of spillover into distant areas. In some cases this acute gangrenous extension may be so widespread that death ensues regardless of adequate surgical drainage of the abscess. In other cases of the second group, pneumonic spread occurs more slowly and the lesion insidiously acquires the characteristic features of the chronic stage, namely, induration, fibrosis, multiple cavity formation, and bronchiectasis. These features, when present, are to be noted only in

TABLE I

RESULTS OF DRAINAGE OPERATIONS

A. Localized Lesions

	Totals	Cured	Improved	Dead	Inadequate Follow-Up
Subacute	25	19	0	6	0
Primary chronic	31	23	3	4 (1 suicide)	1
Secondary chronic	7	5	1	0	1
Totals	63	47	4	10	2

B. Diffuse Lesions

Subacute	6	0	0	6	0
Primary chronic	26	5	6	12	3
Secondary chronic	9	0	2	7	0
Totals	41	5	8	25	3

C. Putrid Empyema or Pyopneumothorax

(Differentiation between localized and diffuse pulmonary lesions not possible)

Totals	15	5	2	7	1

the later part of the subacute stage. On the other hand, the localized type of lesion may be encountered throughout the subacute phase.

From the foregoing, it is clear that the selection of cases of subacute abscess suitable for drainage operations should be based upon the differentiation between the localized and diffuse forms of the disease. The methods to be employed in attempts to differentiate between the two types will be discussed separately. They consist of roentgenography and bronchoscopy, and bronchography under special circumstances.

In our series of 31 operative cases of subacute putrid pulmonary abscess, no selection was made in accordance with the known or assumed type of lesion, because the importance of this differentiation was not realized at the time. The lesion found at operation in 25 cases was of the localized type, and in six was of the diffuse type (Table I). Although the most important criterion of operability by drainage should have been a localized cavity with comparatively little surrounding pulmonary infiltration, fibrosis, and bronchiectasis, drainage operations were attempted or performed in six cases which would be classified to-day as unsuitable for this type of operative procedure. These cases were operated upon during a period in which alternative worth while operative procedures had not as yet been developed.

Of our 31 operative cases of subacute putrid pulmonary abscess, 19 were cured and 12 died (Table I). In all 19 cured cases, the lesion was of the localized variety, proving that surgical drainage is an effective form of therapy in this type of case. In six of the 12 cases that ended fatally, the lesion was of the localized type. Death due to pleural infection occurred in four of these cases, because of pleural entry at the time of operation; and in two cases death resulted from spillover gangrenous bronchopneumonia. We believe that the deaths due to pleural infection would probably not occur to-day because of precise methods of localization and our present operative method of dealing with the opened pleura.

Of the six fatal cases with lesions of the diffuse type prior to operation, three died of pleural infection which also might have been avoided. In the remaining three, the fatal termination was due to spillover gangrenous bronchopneumonia, which probably was unavoidable (Table II). In short, in seven of the 12 fatal cases death was due to postoperative pleural infection alone or in combination with some other infective lesion (suppurative pericarditis, mediastinitis, spillover bronchopneumonia).

The remaining five cases, in which death was due solely to spillover gangrenous bronchopneumonia, require special consideration (Table II). Spillover gangrenous bronchopneumonia is not uncommon in subacute abscess of the lung, and is one of the great dangers in that stage of the disease. It may occur spontaneously during this phase or may be precipitated by operation. Further emphasis is placed on the importance of spillover bronchopneumonia by the fact that this complication was a contributing factor to the mortality in several of the cases in which pleural or other infections occurred after operation.

Chronic Abscess.—At the time of operation, approximately 80 per cent of the cases of chronic abscess of the lung in our series were of four to 12 months' duration. The remainder had lasted from two to nine years. As in subacute abscess, the cases were of the localized and diffuse varieties. The localized form was not distinguishable, pathologically, from that noted in subacute abscess. In the diffuse form the lesion extended beyond one bronchopulmonary segment and usually was accompanied by considerable pulmonary infiltration, fibrosis, and bronchiectasis. Not infrequently there were multiple

abscesses or involvement of several lobes and, at times, of the opposite lung. Occasionally the original pulmonary abscess was more or less completely obscured by extensive induration and fibrosis.

TABLE II

CAUSES OF DEATH

	Localized Type	Diffuse Type	Totals
Subacute Cases			
Pleural infection	4	0	4
Pleural infection plus mediastinitis	0	1	1
Pleural infection plus pericarditis	0	1	1
Pleural infection plus spillover gangrenous bronchopneumonia	0	1	1
Spillover gangrenous bronchopneumonia	2	3	5
Totals	6	6	12
Primary Chronic Cases			
Cerebral metastases	1	4	5
Sudden death on table (cerebral embolism?)	1	3	4
Metastatic renal abscess	1	1	2
Hemorrhage	0	1	1
Empyema	0	1	1
Gangrenous spillover bronchopneumonia	0	1	1
Suicide	1	0	1
Operated upon in moribund condition	0	1	1
Totals	4	12	16
Secondary Chronic Cases			
Cerebral metastases	0	3	3
Spillover gangrenous bronchopneumonia	0	2	2
Sepsis plus spillover gangrenous bronchopneumonia	0	1	1
Pericarditis ? (no autopsy)	0	1	1
Totals	0	7	7
Perforated Cases			
Sepsis (one due to phlebitis following intravenous therapy)			2
Cerebral metastasis			1
Pulmonary suppuration			1
Spillover gangrenous bronchopneumonia plus pyopneumothorax (contralateral)			1
Cardiac failure			1
Pericarditis			1
Total			7

It is significant that more than half of the lesions were of the localized type. Thus, a substantial proportion of cases of chronic abscess were suit-

able for drainage operations, according to the view which we hold at the present time.

In contrast to the subacute stage, the operative morbidity and, ultimately, the mortality in the chronic stage was due in part to the fact that the disease had progressed to such an extent that adequate surgical drainage did not suffice. In addition, the operative procedure itself often was the direct cause of a fatal complication. We refer, specifically, to the mortality from cerebral embolization initiated by exploratory aspiration through, or hemorrhage from, infiltrated pulmonary tissue (Table II). Indeed, the danger of immediate or postoperative fatal cerebral embolism exists in any chronic case in which a drainage operation is performed if densely infiltrated pulmonary tissue is traversed in order to enter an abscess cavity. The Trendelenburg position at the time of operation, and the use of the cautery instead of the scalpel, may reduce the shockingly high incidence of cerebral complications, but offer no assurance against its occurrence in the presence of densely infiltrated lung. In contrast to the high mortality of operation upon diffuse lesions, the low mortality of operation upon localized abscesses warrants emphasis (Table I).

A contrast is also to be noted between the results which were obtained in surviving patients of both groups, for there was a much higher proportion of cures after operation in cases of localized abscess (Table I). However, improvement rather than cure (absence of symptoms, disappearance of pulmonary infiltration, healed wound) may be the outcome in any case after operation for chronic abscess. Thus, patients who survive operation may be left with a bronchocutaneous fistula or "lattice lung," or with symptoms referable to chronic pulmonary fibrosis or bronchiectasis.

Differentiation between Localized and Diffuse Lesions.—Since the differentiation between the two varieties of subacute and chronic abscess is of clinical importance, the methods to be employed for the purpose require at least brief discussion. Typical localized abscess is recognized readily on roentgenography. When the roentgenogram is not characteristic, however, particularly if the cavity is more or less completely obscured by pulmonary infiltration or pleural reaction, the diagnosis of a localized lesion may be difficult. Under these circumstances, bronchoscopic examination (and occasionally bronchography) often will establish the diagnosis of a localized abscess by revealing the escape of pus from a single bronchopulmonary segment. However, the discharge of pus from two adjacent segments does not exclude the existence of a localized cavity. For example, the abscess may bridge an interlobar fissure. On the other hand, the discharge of pus from unrelated segments indicates a diffuse lesion or a multiplicity of lesions.

The diagnosis of a diffuse lesion can usually be made by a study of the roentgenogram combined with bronchoscopic examination. It is important to remember that the interpretation of roentgenograms may be faulty, especially in chronic cases, because of shadows due to pleural involvement. If doubt exists as to whether or not a lesion is of the localized type, one should proceed on the assumption of a localized lesion.

In a few instances good results followed drainage of diffuse lesions (Table I). Emphasis, however, should be placed on the fact that these patients required multiple operations, which were often hazardous, that serious complications occurred, and that the postoperative course sometimes was unsatisfactory for long periods. Therefore, the conclusion is justified that drainage operations should not be employed in cases of abscess of the lung of the diffuse type. Whether more radical surgical procedures such as lobectomy or pneumonectomy meet the requirement of good results with low mortality remains to be seen.

Secondary Cases of Abscess of the Lung.—This comprises a series of 16 cases first operated upon elsewhere for chronic pulmonary abscess or a complicating putrid pleural infection (Table I). They presented special problems in diagnosis, localization, and operative management, and, therefore, are discussed separately. In some cases, pneumonotomy for drainage of the pulmonary abscess was performed several times before admission. The most significant fact is that in nine of the 16 cases of which this group is comprised, the sole operation performed before admission was drainage for empyema. In most of these instances, drainage was carried out in the acute or subacute stage of the disease with *apparent* cure in several cases. However, in such cases, symptoms of chronic abscess subsequently made their appearance after symptom-free intervals. At the time of admission to the hospital all were definitely chronic. The localization of the abscess may be difficult or even impossible from a roentgenologic study, if the lesion is obscured by thickened pleura. Examination of roentgenograms made in earlier stages of the disease, prior to the first operation, may prove of great value in this connection. Localization of the lesion or lesions by bronchoscopy is almost always indicated in these cases, and is of particular value if roentgenographic localization is difficult. The series of cases is too small to permit of statistical analysis, but there were approximately the same number of cases in the localized and diffuse groups. It is significant that all cases of localized abscess recovered after operation, whereas all cases of diffuse abscess, with one exception, died after operation.

Putrid Pyopneumothorax or Empyema Unrelated to Surgical Intervention.—This may occur at any time during the course of subacute or chronic abscess. In this series it was most common in advanced chronic cases and often was an ominous complication (Table I). A study of our cases reveals the interesting fact that the pleural infection was usually, if not always, derived from an *acute* pulmonary abscess complicating the chronic lesion. Thus, the empyema (or pyopneumothorax) was situated either immediately adjacent to the chronic pulmonary abscess and was derived from a recent gangrenous extension into adjacent parenchyma, or when situated at some point distant to the chronic abscess was derived from spillover infection. This group of cases should be classified separately for two reasons: First, because they may present separate problems; and second, because they are often terminal compli-

cations of chronic pulmonary abscess. The results of their treatment are to be found in Table I.

Technic of the Drainage Operation.—The operation which we have employed in cases of subacute and chronic abscess is similar to that which we have developed and utilized in cases of acute abscess. It is based upon two features of our concept of the pathology of the disease: (1) Superficial situation of the abscess within a pulmonary lobe; and (2) the constant presence of overlying adhesions which are most commonly visceroparietal (costal). The operative procedure consists essentially of a one-stage operation in which the abscess cavity is entered through the zone of visceroparietal adhesions, unroofed, and packed with gauze. The details of the procedure, which have been published elsewhere, will not be repeated. Certain features, however, appear worthy of reiteration. The Trendelenburg position is favored because it may reduce the incidence of cerebral embolism. The operative approach is made at the site at which the pulmonary lesion is in contact with the thoracic parietes. Rib resection is of limited extent in order to avoid unnecessary exposure of the pleura beyond the zone of limiting adhesions. As a rule, only a portion of one rib is removed, but occasionally a segment of a second rib is removed in order to facilitate adequate unroofing of large lesions. Since the cavity is usually to be found superficially within the pulmonary substance, if the site of approach is correct, aspiration in order to locate the abscess should be performed under the guidance of the roentgenogram. The danger inherent in aspiration of indurated lung has already been stressed. Therefore, the direction and depth of aspiration should be considered carefully each time it is performed. When the cavity is located, it is entered with a specially designed grooved director and double-edged scissors, and evacuated by suction. The interior then is inspected under direct illumination with a sterile light, and a search made for recesses and communicating loculations. The roof of the cavity and of any adjacent superficially situated loculations is excised. Communicating loculations in the depths are dealt with by providing a free opening between them and the main cavity. Bleeding, which may occur during this step, should be controlled promptly by temporary pressure in an attempt to avoid cerebral embolism. After all recesses and loculations have been cared for, the abscess cavity and its recesses are packed with gauze.

In the occasional case in which the lesion does not face the thoracic parietes, but faces one of the interlobar fissures, the mediastinum, or diaphragm, adhesions between the lung and the parietal pleura are usually absent or insignificant. Under such circumstances, originally we performed the traditional two-stage operation, but finding the results unsatisfactory, the procedure was modified. At present, we suture the lung into the operative wound and proceed with the evacuation of the abscess in one stage.

In cases in which the free pleura was accidentally entered during the course of operation, we formerly attempted to shut off the pleural opening by packing with gauze. This was followed by a high incidence of pleural infection, with high mortality (Table II). Subsequently, all accidental pleural

openings were closed by suturing the lung to the margins of the pleural defect and the overlying soft parts. Since employing this method, there have been no pleural infections.

In a few of the subacute and in many of the chronic cases, multiple drainage operations were performed. The lesions which were opened secondarily either were present at the time of the original operation or else developed subsequently. Depending upon their sites, some were opened through the original operative wound, while others were opened through new incisions. The large number of secondary operations necessary in subacute and chronic cases as compared with the small number in acute cases, is the best commentary on the increasing incidence of multilocular and multiple lesions as time progresses.

In previous communications we stressed the fact that in cases of acute abscess practically all bronchial fistulae closed spontaneously, and that one of the chief problems in postoperative management was that of keeping the fistula open for a sufficiently long period. This, as a rule, is not a problem after operation in cases of chronic abscess. In the latter, the pulmonary cavity is smooth-walled, and, while the cavity may become smaller, it often presents the mouths of one or more discharging bronchial fistulae. In such cases it is our custom to keep the external communication open with a tube until all traces of anaerobic infection have disappeared. In chronic cases of long standing this may require many months. Experience has demonstrated that in cases of doubt, it always is wiser to leave the tube in place rather than to risk premature closure of the wound and recrudescence of infection. During the months that the tube is in place, the superficial portion of the fistulous tract not infrequently becomes lined by skin so that a bronchopulmonocutaneous fistula results. When this occurs, the cavity and the fistulous tract may require some type of plastic closure. This we have accomplished, most commonly, by the use of a free fat transplant which has yielded satisfactory results in a high percentage of cases.

SUMMARY.—Subacute abscess is defined arbitrarily as one of seven to 12 weeks' duration. A chronic abscess is defined as one of more than 12 weeks' duration.

Subacute and chronic abscess may be of either the "localized" or "diffuse" type. The localized type is characterized by a mono- or multilocular cavity with limited surrounding pulmonary infiltration. The diffuse type is characterized by multilocular or multiple cavities with more or less extensive surrounding pulmonary infiltration, induration, fibrosis, and bronchiectasis.

The great majority of primary (previously unoperated) cases of subacute abscess were of the localized variety. Approximately half of the chronic abscesses, whether primary or secondary, were of the localized type.

Operations in all cases consisted of drainage or attempts at drainage. Cure resulted after operation upon the localized form of subacute pulmonary abscess in all patients who survived. Operation on the diffuse form of subacute pulmonary abscess was fatal in all cases. The chief causes of mortality after

operation for subacute abscess were pleural infection, which is avoidable, and spillover gangrenous bronchopneumonia, which is probably unavoidable.

The results of operation upon the localized form of chronic abscess, whether primary or secondary, were good. On the other hand, the results of operation upon the diffuse form of chronic abscess, whether primary or secondary, were bad, and the mortality was very high.

The differentiation between the localized and the diffuse form of subacute and chronic pulmonary abscess is based upon roentgenography and bronchoscopy, and bronchography in selected cases.

Subacute and chronic putrid pulmonary abscess complicated by putrid pleural infection presents special features and comprises a separate problem.

CONCLUSIONS

Subacute and chronic pulmonary abscess occurs in localized and diffuse form. The great preponderance of cases of subacute putrid pulmonary abscess, and a surprisingly large proportion of chronic cases, are of the localized type and are amenable to cure by surgical drainage. The results are usually good. The mortality should be low, since the most common cause of death after operation—pleural infection—is avoidable with precise preoperative localization of the lesion and adequate surgical technic.

Cases of subacute and chronic putrid pulmonary abscess of the diffuse type rarely are amenable to cure by surgical drainage. The results of drainage operations usually are poor because the disease is widespread, and the mortality is high.

The differentiation between the localized and diffuse forms of subacute and chronic abscess is of basic importance in selecting cases for drainage procedures.

REFERENCES

[1] Cutler, Elliott C., and Gross, Robert E.: Nontuberculous Abscess of the Lung, Etiology, Treatment, and Results in 90 Cases. Jour. Thor. Surg., 6, No. 6, 125, December, 1936.

[2] Glass, A.: The Bronchopulmonary Segment with Special Reference to Putrid Lung Abscess. Am. Jour. Roentgenol., 31, 328, 1934.

[3] Neuhof, Harold: The Free Transplantation of Fat for the Closure of Bronchopulmonary Cavities ("Lattice Lung"). Jour. Thor. Surg., 7, No. 1, 23, October, 1937.

[4] Neuhof, Harold, and Touroff, A. S. W.: Acute Putrid Abscess of the Lung. Surg., Gynec., and Obstet., 63, 353, September, 1936.

[5] Neuhof, Harold, and Touroff, A. S. W.: Acute Putrid Abscess of the Lung: II. An Analysis of 45 Consecutive Operative Cases. Surg., Gynec., and Obstet., 66, 836, May, 1938.

[6] Neuhof, Harold, and Wessler, Harry: Putrid Lung Abscess. Jour. Thor. Surg., 1, 637, 1933.

[7] Stern, Leo: Etiologic Factors in the Pathogenesis of Putrid Abscess of the Lung. Jour. Thor. Surg., 6, 2 and 202, 1936.

[8] Touroff, A. S. W.: The Evacuation of Deep-Seated Abscesses. Annals of Surgery, 94, 477, 1931.

[9] Touroff, A. S. W., and Neuhof, Harold: Acute Putrid Abscess of the Lung: III. Roentgenographic Features. Surg., Gynec., and Obstet., 68, 687, March, 1939.

DISCUSSION.—DR. ADRIAN VAN S. LAMBERT (New York) objected to the term putrid in lieu of acute abscess, and felt that patients with an acute abscess should be treated as surgical cases from the beginning, with the surgeon calling in a medical consultant when required. Doctor Lambert also emphasized that no region in the body, except possibly the skull, requires such accurate localization of the lesion as the chest, and upon such localization often depends the success or failure of the case in the operating room.

Doctor Lambert also said that the period of time adhered to by many for conservative treatment of lung abscesses had often been too long—to the detriment of the patient. The inclination at Bellevue Hospital is to watch the patient with an acute abscess for a certain period of time, and not to operate without careful study and consideration, but three months is usually too long, and perhaps even six weeks is also. Three factors have brought about the prevailing point of view at Bellevue, and these are: First, in the presence of the Friedländer bacillus the patient is not operated upon as though the case were one of acute abscess. Secondly, at Bellevue, a number of water-front cases are brought in after submersion, during which the patient has drunk or otherwise inhaled foul sewage from the East River, and within three or four days a fluid level is present. To operate upon such a person has proved unwise. In the few cases that have been operated upon there have not been any adhesions. Doctor Lambert said that in his experience not all acute abscesses are adherent to the pleura, and even a roentgenologic examination will not provide absolute criteria in determining the presence or absence of adhesions unless there is air in the pleural cavity. A third reason for not immediately plunging into an abscess, is because a number of cases come in every year with evidence of acute suppurative disease, who, upon study, prove to have had a previous bronchiectasis for many years, undiagnosed, unnoticed, or forgotten. Attempting to effect simple drainage of an acute lesion in such a patient is one of the reasons operations in chronic abscess cases have been so unsatisfactory. Doctor Lambert said he preferred to wait and perform a lobectomy and excision in these cases.

DR. HAROLD NEUHOF (closing) said that the crux of the matter rested upon whether an abscess is or is not putrid. In employing the term putrid for abscess of the lung, he referred to a very definite type of abscess. One could, he supposed, use the term anaerobic, but neither he nor Doctor Touroff felt free to do so until adequate bacteriologic evidence of the anaerobic nature of the infection could be established. In nonputrid abscesses of the lung the result of infection by streptococci, pneumococci, staphylococci, or other aerobic organisms, the lesion is an area of pneumonia in which more or less widespread suppuration exists. Only in occasional instances is there a well-defined, well-circumscribed collection of pus with limited surrounding pulmonary infiltration. The problem presented by these cases, and their general management, is quite different and most of them should not be the subject of surgical consideration. Spontaneous subsidence occurs frequently, and the chief surgical significance of aerobic abscess of the lung perhaps rests on occasional perforation into the pleura with the formation of a pyopneumothorax. Thus, these are not the cases referred to in the paper by himself and Doctor Touroff.

Putrid abscess of the lung begins as a gangrenous bronchopneumonia which, however, breaks down and forms an abscess within a week or ten days. There is usually only a limited surrounding zone of pneumonitis. The abscess is always of substantial proportions and, being segmental in nature and occupying much of a bronchopulmonary segment, must, of necessity, reach to

the periphery. In reaching to the periphery, there must, of necessity, be an overlying pleuritis. This pleuritis leads, invariably, to shutting off pleural adhesions. The latter are visceroparietal in the great majority of instances. Exceptionally, because of the unusual situation of the abscess, adhesions are from lobe to lobe across a fissure, or from lobe to diaphragm, or from lobe to mediastinum. Surgically speaking, it, therefore, becomes a matter of deciding where the adhesions exist, not if they exist. Not only were they present in all the ten cases of acute abscess upon which Doctor Neuhof and Doctor Touroff had operated, but were sufficiently firm and widespread to warrant a one-stage operation in the great majority of instances.

OBLITERATION OF THE PLEURAL SPACE FOLLOWING PNEUMONECTOMY*

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THE CHIEF INDICATION for pneumonectomy up to the present is the presence of cancer of the lung. Recognition of malignant lung tumor first appeared in the writings of Agricola,[1] in the early sixteenth century. Bell is credited with making the first diagnosis of *primary* lung tumor, in 1846. His case is now classified as lung sarcoma.[1] The first successful treatment of bronchogenic carcinoma was not until 1933, when Graham removed the entire left lung for a primary growth in the left main stem bronchus. The patient, a doctor, is asymptomatic and is actively engaged in practice seven and one-half years following the operation.

The early recognition of lung tumor from clinical symptoms, bronchoscopic, roentgenologic and bronchographic examinations has led to frequent exploratory thoracotomy. Operable carcinomata of the lung are thus discovered earlier, and are now quite often successfully removed surgically. The improvement of the surgical technic of pneumonectomy has been largely due to the efforts of such courageous surgeons as Graham, Churchill and Rienhoff, in America, and Edwards and Roberts, in England. Graham's original pneumonectomy was accompanied by an extensive thoracoplasty to obliterate the remaining pleural space. The operation, as it is usually performed to-day, seldom entails the removal of more than one rib. The remaining pleural space is only partially obliterated by paralyzing the diaphragm.

The changes in respiratory physiology, following total ablation of one lung with the anatomic readjustment in the thoracic cage, are not well understood. The dangers of sudden shift of the mediastinum in intrathoracic surgery has been greatly feared in academic circles. This has resulted, in part, from experiences with the original Brauer thoracoplasty for pulmonary tuberculosis. Many of these patients developed a mediastinal flutter due to an unstable chest wall following extensive rib resection. The principal factor, however, has been the lack of understanding of normal cardiorespiratory physiology and its alteration under abnormal conditions such as an open pneumothorax. Graham's physiologic studies, in 1918, demonstrated con-

* This work has been conducted in part under a grant from the Douglas Smith Foundation for Medical Research of the University of Chicago, Chicago, Ill. Submitted for publication December 28, 1939.

clusively the importance of vital capacity (amount of functioning lung tissue) in the presence of an open pleural cavity. Reports from other clinics, as well as experience in this clinic, indicate that compression of the great vessels resulting from marked deviation is the principal danger from mediastinal shift when an adequate amount of lung tissue is functioning. We have had one instance where definite circulatory and respiratory embarrassment did result from spontaneous pressure pneumothorax in a surgically produced extrapleural space. Mediastinal shift was only of secondary importance in this case. Relieving the pressure pneumothorax brought about immediate alleviation of the symptoms. Untoward symptoms of mediastinal shift following lobectomy, pneumonectomy, or thoracoplasty have not been met with in this clinic. That there has been definite shift of the mediastinum is well known both from roentgenographic and autopsy observations.

In pneumonectomy for carcinoma of the lung a preoperative pneumothorax is produced to collapse the entire lung on the involved side as much as possible before attempting the operation. This collapse brings about diminished blood flow through the lung, allowing respiratory compensation to occur gradually, and tends to cause thickening of the pleura of the chest wall and of the mediastinum. Bloch[2] has shown that in rabbits the mediastinum does not thicken during pneumothorax. No reported studies, so far, have proven that the human mediastinum does thicken during pneumothorax, but clinical observation at the time of operation, as well as roentgenologic examination, indicates that at least the mediastinal pleura does thicken appreciably if pneumothorax is of long duration. It is doubtful that the short period of immediate preoperative pneumothorax stimulates thickening or fixation of the mediastinum to any demonstrable degree.

Following pneumonectomy there is an accumulation and stasis of a bloody, serous exudate that develops in the pleural cavity and with this a gradual reabsorption of the remaining air. The exudate slowly becomes partially organized and may lead to the formation of fibrous tissue. The parietal pleura becomes markedly thickened. During the process the chest wall on the involved side undergoes shrinkage and the pleural space becomes partially obliterated. The degree to which this process continues varies with the age of the individual and other physical factors which are not well understood. The thickening of the "shell" of fibrous tissue in the ensuing months after operation produces a progressive increase in the contraction of the chest wall. In the case to be reported there was an incased pocket of fluid in this cavity. During the first few weeks following operation this fluid may become infected. If so, the cavity is not likely to become obliterated spontaneously, but will do so following a thoracoplasty, an operation similar to that employed in obliterating a chronic empyema cavity. Rienhoff[3, 4, 5] has found it unnecessary either to drain these cavities or to perform thoracoplasty to collapse them if no infection ensues, and at the present time this is the procedure employed by most surgeons. F. E. Hambrecht[6] used closed drainage of an infected pleural space following pneu-

monectomy for bronchogenic carcinoma in one case, which resulted in complete healing without thoracoplasty.

We are reporting a case that died of an unrelated cause nine months following a pneumonectomy for carcinoma of the left lung.

Case Report.—Hosp. No. 191716: H. R., white, male, age 58, was admitted to the University of Chicago Clinics, January 26, 1938, complaining of cough with blood-tinged sputum for one year, night sweats for three months, and a loss of ten pounds in weight.



A B

FIG. 1.—(A) Roentgenogram of chest on admission. Note the opacity extending outward from the left hilum. This is characteristic of pneumonitis and atelectasis resulting from bronchial obstruction.
(B) Roentgenogram of chest following preoperative collapse of the left lung by pneumothorax.



A B

FIG. 2.—(A) Roentenogram of chest 30 days following extirpation of the left lung. The left diaphragm is elevated, and a serosanguineous exudate has almost completely replaced the air in the left pleural space.
(B) Roentgenogram of chest eight months after left pneumonectomy. The left diaphragm is considerably elevated, the interspaces narrowed, and the superior mediastinum deviated toward the left side.

A roentgenogram of the chest showed an opacity, suggestive of atelectasis and pneumonitis of the left hilar region of the lung (Fig. 1 A). Bronchoscopic examination and biopsy proved the diagnosis of squamous cell carcinoma of the left main bronchus. The left lung was collapsed by pneumothorax preceding the operation (Fig. 1 B).

The entire left lung was removed February 21, 1938. The postoperative course was relatively uneventful. He was discharged 42 days after operation. Three months after operation he was given 3,028 r units in divided doses over the mediastinal area. There was a very mild reaction to the irradiation. Fluoroscopic examinations made at that time showed a marked increase in density of the left pleural space.

Throughout the ensuing months he had a mild, persistent cough, occasionally raising a small amount of mucus-like material. He gained three pounds in weight and was otherwise in good health generally.

Bronchoscopy performed four months after operation showed no ulceration, carcinomatous tissue or evidence of opening of the bronchial stump of the resected lung. A roentgenologic examination of the chest showed only an elevated diaphragm and a marked increase in density on that side (Fig. 2 A). In a subsequent roentgenologic examination, eight months after operation, there was an increase in the density of the left side of the thorax. The left diaphragm was higher than at the previous examination (Fig. 2 B). The patient continued in general good health.



FIG. 3.—Anterior view of the contents of the thorax after removal of the sternum and costal cartilages at autopsy. The right lung (A) appears normal. The contracted left pleural space (B) is obliterated by a mass of fibrous tissue. The pericardial sac was completely obliterated by adhesions.

Nine months after operation he developed acute abdominal pain, followed by nausea, vomiting and fever. He was first examined about 40 hours after the onset. A diagnosis of an acute surgical abdomen was made. At exploratory celiotomy, a gangrenous appendix with general peritonitis was found. He died three days later of the peritonitis.

Autopsy.—Path. No. 4581: Dr. Paul R. Cannon. The entire left chest cavity was lined with a well-organized, dense, fibrous labyrinthine shell which contained a brownish, turbid sterile fluid. This shell varied from 0.5 to 2.0 cm. in thickness. The right lung exhibited no gross evidence of emphysema. The heart was slightly enlarged and adherent to the fibrous tissue shell. The pericardial cavity was completely obliterated. There was moderate collapse of the left pleural cavity by contraction of the chest wall (Fig. 3). The hilar lymph nodes at the stump of the left main bronchus contained carcinoma cells. There was no evidence of distal metastases of the tumor. Microscopically, the wall of the shell showed only fibrous tissue with occasional fibrocytes.

In an effort to produce and explain similar respiratory changes, we have carried out left-sided pneumonectomies upon dogs and have studied their reaction to the diminished lung capacity. In very few instances was there evidence of dyspnea. The hemoglobin and hematocrit readings increased immediately after pneumonectomy in most dogs, but returned to normal in a few weeks. About six weeks after the pneumonectomy we began to effect stenoses of the bronchi of the three most dependent lobes of the remaining right lung. Several of these animals are apparently quite normal, even though only the right upper lobe is functioning. Unlike adult man, the dog's mediastinum is very mobile. Following the resection of an entire

lung with gradual resorption of the remaining air in the pleural space, the mediastinum is slowly deviated toward the chest wall of that side. Very little pleural exudate develops and the parietal pleura exhibits little or no increase in thickness.

The clinical case presented is especially valuable as a specimen for study of the anatomic changes that occur in the chest following removal of one entire lung. This patient had a well-organized, unnecessary fibrous cone replacing the excised lung and suffered no apparent respiratory embarrassment. From the facts cited in clinical experience, and the animal experimental evidence, it is obvious that the margin of safety is wide and that there is an ample excess of lung tissue to permit the removal of an entire lung without producing respiratory embarrassment following ordinary activity.

REFERENCES

[1] Simons, E. J.: Primary Cancer of the Lung. The Year Book Publishers, Inc., 1937.
[2] Bloch, R. G., and McLean, M. C.: Experimental Studies on Lung Collapse in the Rabbit. Jour. Clin. Invest., 9, 13, 1930–1931.
[3] Reinhoff, Wm. F., Jr., *et al.*: Thoracic Readjustment Following Complete Removal of the Lung. Tr. Assn. Amer. Phys., 49, 56, 1934.
[4] Reinhoff, Wm. F., Jr.: Readjustments in the Thoracic Cage and Its Contents Following Total and Partial Pneumonectomy. South. Med. Jour., 29, 485, 1936.
[5] Reinhoff, W. E.: Intrathoracic Readjustment Following Complete Ablation of One Lung. Jour. Thoracic Surg., 6, 254, 1937.
[6] Hambrecht, F. E.: Personal communication.

RUSSELL TRACTION IN THE TREATMENT OF FRACTURES OF THE FEMUR*

OBSERVATIONS ON ONE HUNDRED FIFTY-SIX CASES

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IN LOOKING back over the evolution of the treatment of fractures of the femur, one is impressed by the rapid changes that have taken place. It is barely two decades since ice-tongs and plaster spicas were used extensively. It is even less since Steinman pins and Kirschner wires first made their appearance. When one considers the relatively short space of time that has passed between the popularity of each of these methods it would hardly seem necessary to urge that they have proven inadequate to obtain the results which we desired. Anyone who has had any experience in handling femur fractures can testify to the great difficulty that was frequently encountered in obtaining adequate reduction either by skeletal traction or by manual reduction and encasement in plaster. An infected knee joint or osteomyelitis was an occasional complication and always a source of worry. In a paper read before this Society in March, 1937, Kennedy,[26] reviewing a series of 120 cases treated by these methods, showed a high percentage of tong and pin wounds and general dissatisfaction with the use of plaster spicas. His conclusions seemed to be that some more efficient method should be employed in handling these fractures and that skeletal traction was far from the ideal solution.

Although Russell[1] suggested his method for treating fractures of the shaft of the femur in 1924, it was not until 1927 that Ryan,[2] of Philadelphia, brought the method to the attention of American surgeons. Published reports on the results obtained with this method have not been as numerous as one might expect and to many who have adopted it at all extensively, there is a certain lack of understanding as to its rather apparently limited use. As late as January, 1937, Van Gorder,[23] reporting a series of 105 consecutive femur shaft fractures from the Massachusetts General Hospital, did not even mention the Russell method of traction, even though he admitted that their current method of treatment necessitated open reduction in 25 per cent of their cases. In several other recent reports on large series of femoral shaft fractures,[7, 22, 24] the authors, similarly, seem to have omitted this method from their armamentarium. Where the method has been used, however, it has been so enthusiastically endorsed that it is difficult to understand why the reports have been relatively so few.[3, 4, 5, 6, 8, 9, 11, 12, 13, 14, 15, 19, 20, 25] Several authors,

* Read before the New York Surgical Society, December 6, 1939. Submitted for publication November 6, 1939.

notably Sallick,[16, 18] and Impink and Lee,[17] have called attention to its value and have strongly urged its more general adoption.

The results of open reduction of shaft fractures may be excellent under ideal conditions and in certain hands, and one may not agree entirely with Russell's dictum that "there is only one circumstance that can justify such a surgical procedure—that is mechanical impediment to the reposition of the fragments." One must, however, agree with Sallick that, whereas, open fixation may be the ideal form of treatment, its routine use is, in most hospitals, quite impractical and not without danger. Van Gorder's[23] series of cases, where the operative work was performed in a well recognized hospital, showed an infection rate of 15.4 per cent, which the author himself notes is deplorably high. Acknowledging that the infection rate might usually be expected to be much lower than this, it seems to be generally accepted that the routine use of open reduction and internal fixation would, in the majority of institutions, not be feasible. Weil, Kuehner and Henry,[24] reporting 103 operated cases, had five infections, with two deaths from septicemia, an infection rate of 4.8 per cent.

Because of our lack of satisfaction with the results that we were obtaining in femoral shaft fractures by means of skeletal traction, the Russell method was adopted on the Fourth Surgical Division of Bellevue Hospital in January, 1930. During the past five years this method has been used routinely for all fractures of the femoral shaft together with intertrochanteric fractures, but excluding fractures of the femoral neck that could be handled by any other means. Our routine of treatment has not differed materially from Russell's original description, except in some rather minor details. Russell's original article is still the best reference, as most of the subsequent commentators agree that, for clarity and brevity, his description cannot be improved upon. A brief comment upon the method as we use it, together with the mechanics involved, will be given later in this report. From January 1, 1930, to July 1, 1939, we have treated 156 patients by this method and feel that this is a sufficient number to justify an analysis of the method, together with some conclusions as to our end-results. There was only one compound fracture in this series. We have not included any cases in which the treatment was interrupted because the patient was unmanageable or where a plaster encasement was applied to permit transportation home or to another hospital.

In studying this series, the cases have been subdivided according to the location of the fracture, as shown in Table I.

TABLE I

LOCATION OF FRACTURE

Intertrochanteric	85
Upper one-third of shaft	23
Middle one-third of shaft	18
Lower one-third of shaft	30
Total	156

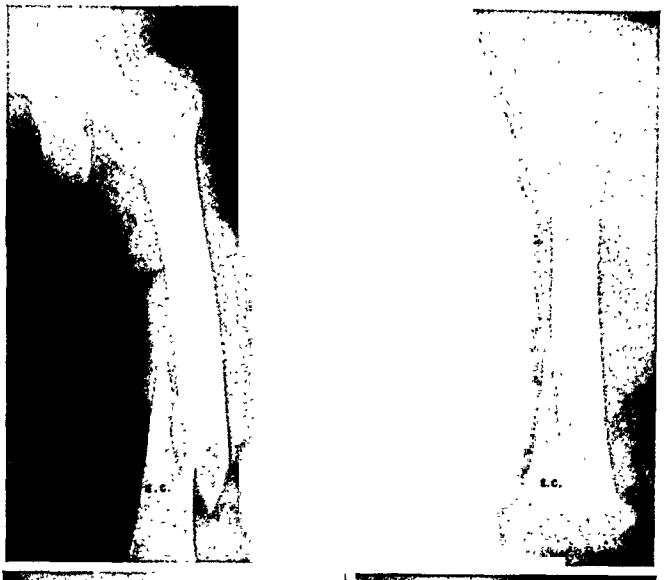


FIG. 1.—Case E. C.: Prereduction. Fracture lower third of shaft.



FIG. 2.—Case E. C.: Post-reduction. After one week in traction.

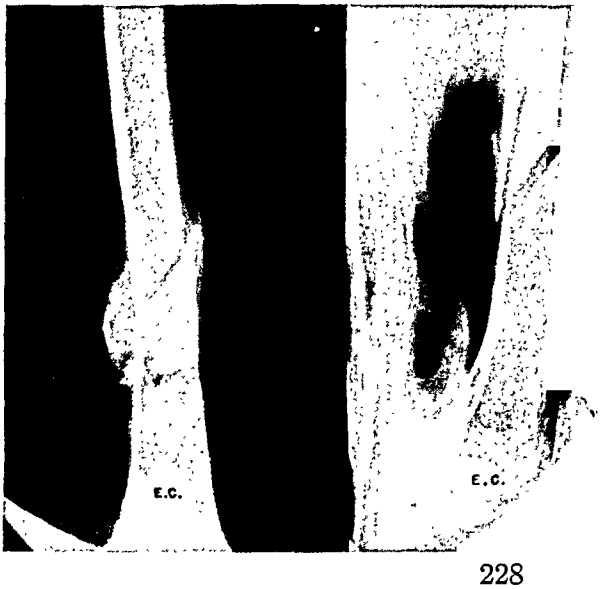


FIG. 3.—Case E. C.: Union after nine weeks in traction.



FIG. 4.—Case W. S.: Preduction. Fracture middle third of shaft.



FIG. 5.—Case W. S.: Postreduction. One week.

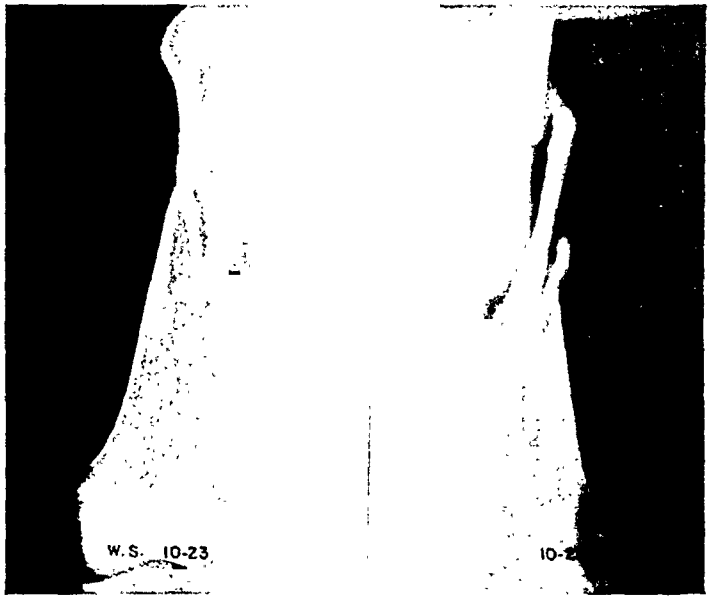


FIG. 6.—Case W. S.: Union after 16 weeks in traction.

In this group of 156 cases, there were seven cases in which adequate reduction could not be obtained. Three of these were in the upper third of the shaft, and four of them in the lower third. One of the patients whose fracture was in the upper third was treated early in our experience with Russell traction and because an adequate reduction could not be obtained it was decided to substitute skeletal traction by means of a Kirschner wire through the condyles. Following this procedure an infection developed which rapidly spread to the knee joint. The patient became desperately ill and, as a life saving measure, a midthigh amputation through the fracture site was performed. A second case in which the method did not give a satisfactory reduction was a patient with a compound fracture of the lower third of the shaft. The wound in this case was carefully débrided but was not closed, and Russell traction was applied. The characteristic posterior displacement of the lower fragment was present and could not be overcome and again, as in the first case, skeletal traction with a Kirschner wire through the condyles was undertaken. The position was much improved, but still not good, and open reduction was being considered. At this time, however, a severe infection developed in the compound wound, postponing all further attempts at reduction, and necessitating an amputation some eight days later. At this time muscle interposition was found between the fragments. Following the amputations, both the patients made satisfactory recoveries. It would seem as though open operation with internal fixation of the fragments would have been a better second choice than skeletal traction in these two cases, and such has since been our routine when Russell traction has not proven adequate. The five other cases all had open reductions with plating of the fragments, at which time it was found that there was muscle interposition in every instance.

The patients were all adults, of whom 74 were men and 82 were women. The youngest was 14 years of age and the oldest 86. The average age was 58. The better general condition of the patients and the ease of handling them, when compared to a similar group treated by skeletal traction, cannot be overemphasized. Most of the patients of advanced age have stood this method of treatment without complication even though traction was maintained in many cases for over 100 days. The patients were all kept in traction until firm bony callus had formed, enabling the patient to get out of bed with the aid of crutches or of an ambulatory Thomas splint. The shortest period that traction was necessary was 42 days and the longest was 135 days. The average period was 78 days.

The weight used for traction varied from five to ten pounds depending upon the muscular development of the patient and the amount of overriding, but in no case was more than ten pounds needed to obtain adequate reduction. In practically all instances five pounds of weight was all that was required to maintain reduction after shortening had been overcome. The estimation of the correction of shortening has always been dependent upon roentgenologic

observation of the fragments and not upon external measurement. The latter method is not as exact and is apt to give rise to many errors.

There were six deaths, a mortality rate of 3.2 per cent, and these were all in aged individuals. The cause of death in each case was the same, *i.e.*, senility plus terminal bronchopneumonia, the patients ranging in age from 70 to 82 years. No deaths occurred in the cases operated upon.

TABLE II

DAYS IN TRACTION AND DURATION OF HOSPITAL STAY

Maximum days in traction	135.0
Minimum days in traction	42.0
Average days in traction	78.0
Maximum days of hospitalization	235.0
Minimum days of hospitalization	52.0
Average days of hospitalization	100.7

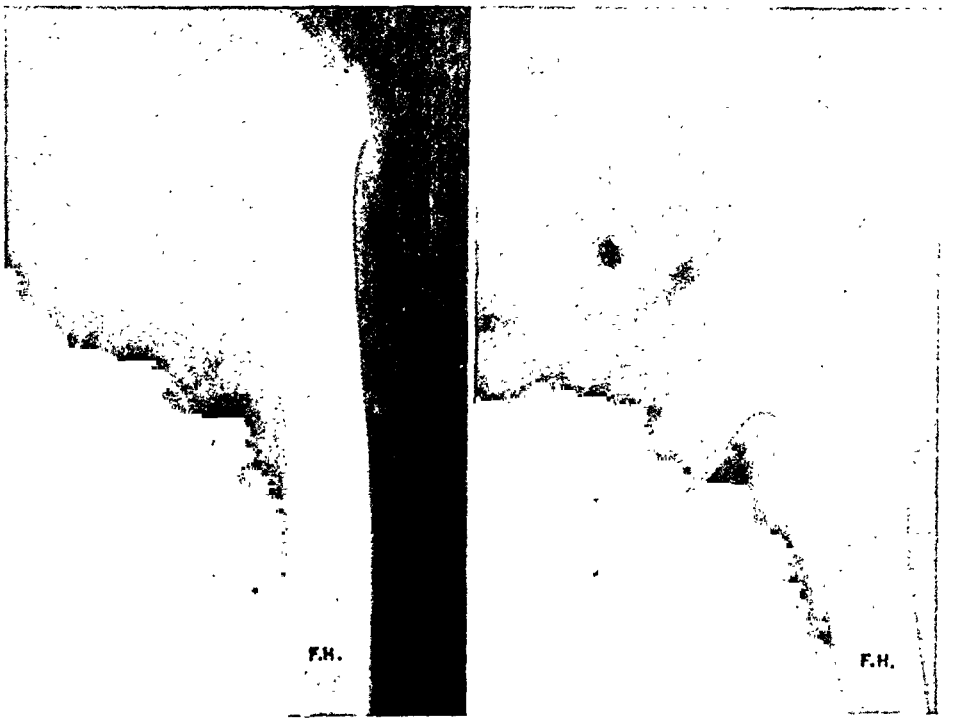


FIG. 7.—Case F. H.: Pre- and postreduction. Intertrochanteric fracture.

An accurate study of the time at which callus first appeared hardly seemed indicated as this is such a variable factor at all ages that it would seem as though no helpful conclusions could be drawn therefrom. For instance, one patient, age 82, with a lower third shaft fracture, showed exuberant bony callus at six weeks (Figs. 1, 2 and 3), whereas a young adult male, age 35, showed only very limited callus at 16 weeks (Figs. 4, 5 and 6). In both instances reduction was excellent and there was good bony contact between the fragments.

Evaluation of Results.—Of the 156 cases treated, seven could not be adequately reduced, and open reduction with Lane plating was performed in

five, with the regrettable amputations above cited in the other two. Six other patients died during the course of treatment, leaving 143 patients treated by Russell traction alone, who could be followed to an end-result. Of these, 77 had intertrochanteric fractures, 21 had fractures of the upper third of the shaft, 17 had fractures of the middle third of the shaft, and 28 had fractures of the lower third of the shaft. In all of these 143 cases reduction was readily accomplished and overriding corrected (Figs. 7 and 8). Union was obtained in all instances, and all patients were kept in traction until union could be demonstrated both by clinical examination and by the appearance of sufficient callus roentgenologically.



FIG. 8.—Case J. M.: Pre- and postreduction. Intertrochanteric fracture.

In the intertrochanteric group it has been our experience, however, that the demonstration of union is occasionally quite difficult. In the patient with the fat thigh, clinical examination is often of little value, and we have seen a number of cases in which the production of callus was quite limited. The surgeon's judgment as to when such a patient may be safely removed from traction is frequently taxed to the utmost. In our series of 77 intertrochanteric fractures, there were five patients who developed shortening of up to one inch subsequent to their removal from traction. Whether this was due to too short a period of traction, or whether the patient bore weight too early, it is difficult to ascertain. We do feel, however, that few femur fractures should be allowed unsupported weight bearing for at least six months from the time of the injury and this time will frequently be longer in the individual case.

In the shaft fractures, Russell traction has worked admirably except in



FIG. 9.—Case F. S.: Prereduction. Fracture lower third of shaft.

FIG. 10.—Case F. S.: Postreduction. One week and ten weeks, respectively.

the seven patients mentioned above. The ease with which displacement has been overcome has frequently been a source of extreme satisfaction, and we have been particularly fortunate in our results with the lower third fractures, where previous observers have noted difficulty in obtaining adequate reduction in many cases. The tendency of the lower fragment to be displaced posteriorly has been noticed with much less frequency since it has become routine practice in New York to apply Thomas splints with temporary traction at the site of the accident (Figs. 9 and 10). The Russell traction is instituted as soon as the patient is admitted to the hospital, regardless of the time of day or night, as it has always been our feeling that all fractures should be treated as surgical emergencies. Whether the early institution of traction before transportation of the patient to the hospital is a deciding factor in preventing the characteristic posterior displacement in this lower third group, we do not know. We do, however, seem to have had less difficulty in handling this group by the Russell method than had been the case in previous reports. If the Russell traction fails to give a good reduction within 24 to 48 hours, gentle manipulation under light anesthesia, without removing the traction, is suggested. We have become so impressed with the efficaciousness of the Russell method in shaft fractures that it is our feeling that, where reduction cannot be secured, one is usually justified in assuming that muscle interposition is present. In these cases open operation and internal fixation with a Lane plate is advocated.

One patient of particular interest was a female, age 39, who had a fracture of the shaft of both femora. She was handled very satisfactorily by the Russell method, the traction being applied to both lower extremities at the same time. She was in extreme shock for several days and any other method of treatment would have considerably added to the hazards of her recovery. Skeletal traction on both extremities would undoubtedly have been impractical as it would have been almost impossible to have kept from pulling her out of bed. No other instance has been brought to our attention where this method has been used on both limbs simultaneously.

There was no shortening in any of the shaft group, nor did any occur subsequent to the removal of traction. Callus here is usually more exuberant than in the intertrochanteric group, and clinical bony union is much easier to ascertain.

The restitution of joint function in these cases was most rapid and gratifying, and the period of after-care and after-treatment was considerably shorter than in previous patients where incorporation in plaster or skeletal traction was used. The prolonged period of stiff and swollen knees was not seen, and, indeed, joint function, up to a certain point, was always taking place in the hip, knee and ankle even while the traction was on. This was of particular value in the older group, where, as we all know, complete return of joint function previously implied long, tedious effort on the part of the surgical staff and considerable suffering on the part of the patient. Many of

the patients, when treated by the older methods, never did recover entire range of motion in the knee.

TABLE III

SUMMARY OF RESULTS

Total Cases			156
Shafts	71		
Intertrochanterics	85		
Method Unsatisfactory		7	
Open reduction-Lane plate	5		
Amputation (one compound fracture and one Kirschner wire infection)	2		
Deaths		6 (3.2%)	
Total Cases Treated Throughout by Russell Traction			143
Shafts	64		
Good results		64	
Intertrochanterics	79		
Good results		74	
Unsatisfactory results (shortening up to 1 inch developing after traction was removed)	5		
Total Good Results			138

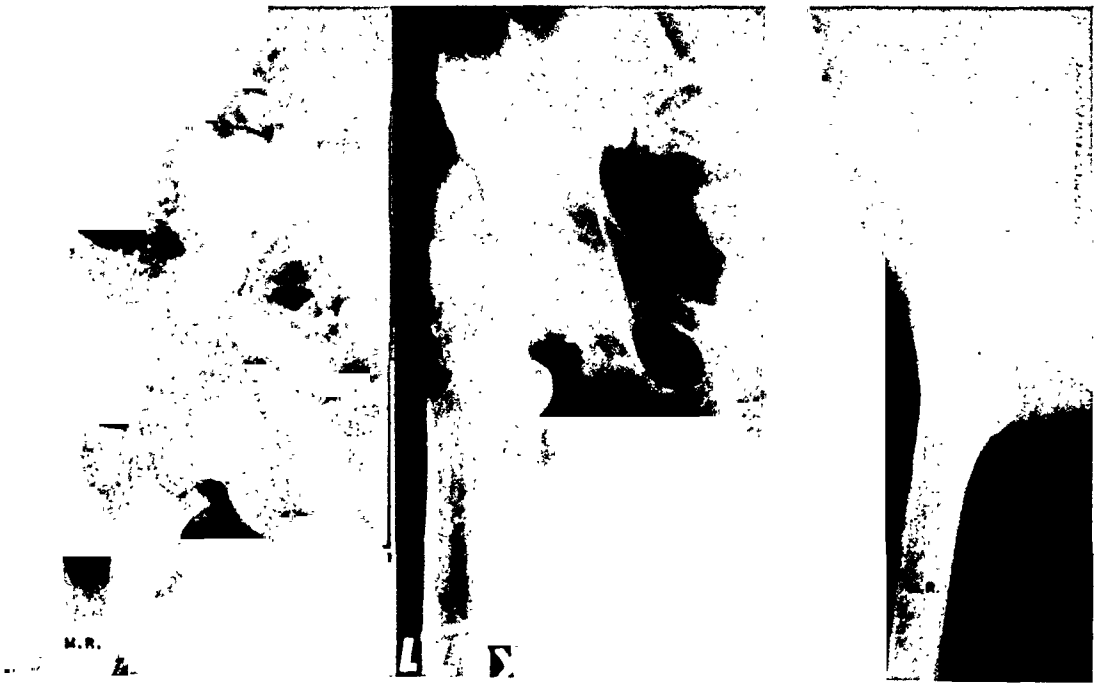


FIG. 11.—Case M. R.: Intracapsular fracture of the neck of the femur. The only case of the type in which union was obtained.

We had the opportunity of observing the efficacy of this method in a series of intracapsular fractures of the neck of the femur in a group of 18 aged individuals in whom other, more appropriate methods of treatment could not be used. These patients were all very senile or were suffering from physical complications of such severity as to make the use of the Smith-Petersen nail out of the question. Four of the patients refused operation

and were placed in Russell traction purely as a palliative treatment. Of the group of 18, five died while in the hospital, the date of death ranging from a few days to six weeks following admission. Two succumbed to senility and malnutrition and the other three to pneumonia. Of the total number, union was obtained in only one case, which occurred in a male, age 62, who refused to have the Smith-Petersen nail used and who was left in Russell traction, without any real hope on our part of his obtaining union (Fig. 11). The fragments were not impacted, there being a small amount of separation, but, even so, union ultimately occurred. We definitely feel that Russell traction should not be used as a method of treatment for fractures of the femoral neck. It is our experience that its use should be limited to that of a palliative method where the fracture has to be disregarded because of the age or physical condition of the patient.

TABLE IV

RESULTS IN INTRACAPSULAR FRACTURES OF THE FEMUR TREATED BY RUSSELL TRACTION

Total cases	18
Deaths	5
Nonunion	12
Union	1

Consideration of the Method Itself.—It is not the purpose of this paper to go into a detailed description of the Russell method or to discuss the mechanics involved. The original description by Russell is still as clear and concise as can be found in any of the succeeding reports, and no improvements on his original description have been brought forth that are of fundamental importance. The routine which we have followed may be briefly summarized as follows:

(1) The foot of the bed is elevated six to eight inches.

(2) The thigh is elevated by a pillow underneath, so that the angle between the thigh and the bed will be somewhere between 15° and 20°.

(3) The overhead pulley should be in a position some place between the tibial tuberosity and the middle of the leg, and the rope running from the sling to the overhead pulley should make a right angle with the leg. The overhead pulley, however, should never be so far below the knee as to cause the sling to slip out of position.

(4) The knee should be slightly flexed, so that the leg will make an angle of 10° to 15° with the bed or, in other words, so that the angle between the knee and the thigh lies between 150° and 160°.

(5) The extremity should not be abducted more than 15° from the midline.

(6) The leg should be shaved before the moleskin is attached, and the moleskin should be allowed to set for at least 20 minutes before any weight is attached.

(7) The head of the bed should never be "gatched-up" while the patient is in traction, although a pillow may be allowed under the head.

(8) Rope should be as small in caliber as can be obtained and pulleys large, although, practically, we have not found that, within reasonable limits, this has made any essential difference in the efficacy of the apparatus.

(9) The weight applied should vary from five to ten pounds. The weight should be immediately reduced if any evidence of overpulling is seen roentgenologically.

(10) A portable roentgenographic apparatus is essential and roentgenograms should be taken every day or two for the first few days, so that the position of the fragments may be constantly checked and overpulling avoided. Overpulling of the fragments should be particularly guarded against, especially in transverse fractures. Blum[27] has pointed out the frequency with which delayed union is associated with this condition.

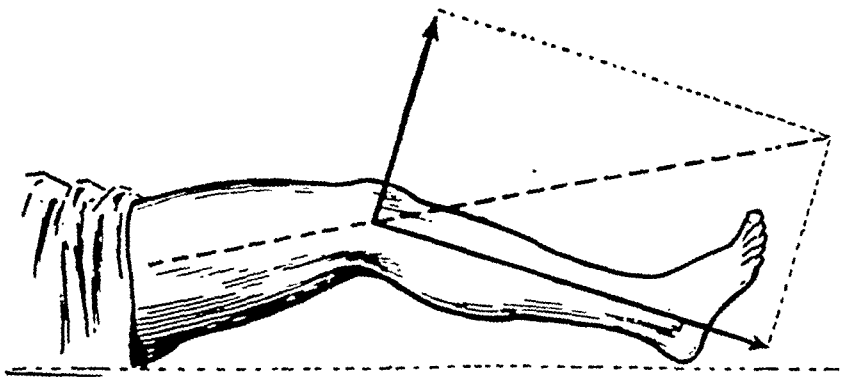


FIG. 12.—Mode of action of the two forces employed. (After Russell.[1])

If the above suggestions are followed, we feel that the mechanics of the method will be automatically taken care of. The line of the femur will become the resultant of the parallelogram formed on one side by the leg and on the other side by the rope running from the sling under the knee to the overhead pulley (Figs. 12 and 13). Mathematically calculated, it has been constantly found that the pull exerted along this resultant and, therefore, along the long axis of the femur is somewhat more than twice the amount of the weight used for traction. The physical and mathematical calculations governing the mechanics of the force exerted along the resultant of the parallelogram constructed by the Russell method are quite complicated and require trigonometric equations to solve them. A complete understanding of these is not at all essential to an adequate appreciation of the method or ability to handle it, and the reader is referred to three excellent articles by Ryan,[2] Lowry,[10] and Wilson[21] on the complete physics and mathematics involved.

The other aspect of the Russell traction method, namely, that of putting the muscles of the lower extremity in a position of physiologic rest by slight flexion at the hip and knee with the added support of the pillows, has not been sufficiently stressed. In this regard it has always seemed to us a trite comparison to note that when we are about to go to sleep the joints of the body are usually in a position of moderate flexion, with the one exception of



FIG 13.—Russell traction properly applied.

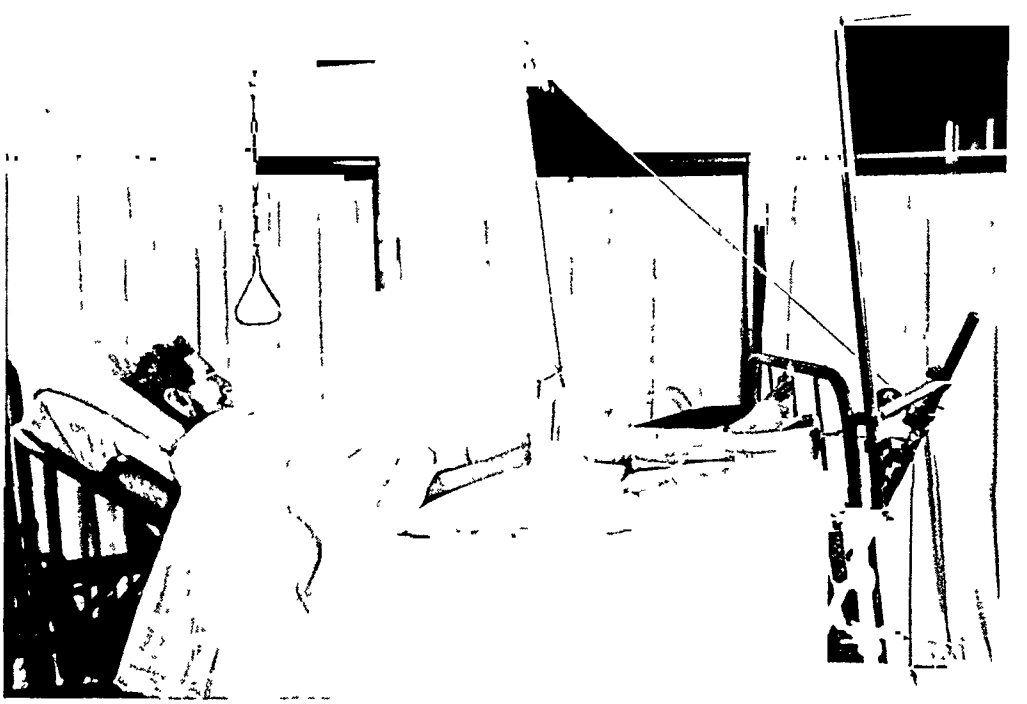


FIG. 14.—Russell traction improperly applied. Note the head of bed "gatched up." Overhead pulley cephalad to knee. Patient slipped down in bed. Mechanics of method destroyed.

the ankle joint. This attitude of limited flexion, then, is probably the one of maximum physiologic relaxation for all muscle groups and, from this fact, we should learn a lesson in our management of fractures. Russell was the first to point this fact out, and our experience with his method amply satisfied us that his observations were correct. If the muscle groups are relaxed to the maximum of our ability, the spasm and tonicity will be greatly lessened, with a consequent relaxation of the muscle pull which is responsible for most of the overriding and displacements in fracture fragments. One only has to observe the ease with which overriding of the femur fragments is usually accomplished by this method in comparison to the difficulties which were not infrequently encountered when skeletal traction was used. In the latter instance, the flexion at the hip was usually much more acute, due to the frequent high elevation of the Thomas splint, as was also the flexion at the knee, where the use of the Pierson extension was so popular. Occasionally, in these cases, even 35 or 40 pounds of traction would not completely correct the overriding, demonstrating that by merely increasing the pull on already traumatized muscles, one could not overcome their contraction. Contrasted to this, the Russell method shows what gentleness in handling muscle groups will accomplish.

Like any system of traction, however, this method requires constant supervision by someone familiar with the necessary essentials. This knowledge is not hard to acquire, but due regard must always be maintained to see that correct angles at the knee and hip are constant, that the overhead pulley is kept in its proper relationship to the upper end of the tibia and that the patient is not allowed to slide down in bed and remain there (Fig. 14). The nursing staff must be taught the proper position of the pillows and of the overhead pulley, so that, when sheets are changed and bed pans passed, the mechanics of the system will not be disturbed. If all of these simple suggestions are followed, one will find the method efficient and safe and eminently more comfortable for the patient than any other system of treatment that we know.

CONCLUSIONS

(1) One hundred fifty-six fractures of the femur treated by the Russell traction method are reported, with good results in 138 cases.

(2) It is the method of choice for intertrochanteric fractures and for all of those involving the shaft.

(3) If good reduction in shaft fractures cannot be obtained, and if gentle manipulation under an anesthetic will not improve the position of the fragments, it may be assumed that muscle interposition is present. Open reduction and internal fixation with a Lane plate is then advocated.

(4) The Russell method is not recommended for treating intracapsular fractures of the neck of the femur and should only be used here as a palliative measure. In 18 cases in which we used it, union was obtained in only one patient.

(5) Skeletal traction should be discarded as a procedure in handling femur fractures.

BIBLIOGRAPHY

[1] Russell, R. Hamilton: Fractures of the Femur—A Clinical Study. Brit. Jour. Surg., 10, 491, 1924.

[2] Ryan, Thomas J.: Use of Russell Apparatus in Treatment of Fracture of Shaft of the Femur. ANNALS OF SURGERY, 85, 529, 1927.

[3] Ridgely, I. O., and Bongardt, H. F.: Treatment of Fractures of the Femur by the Hamilton Russell Method of Traction. Amer. Jour. Surg., 7, 251, 1929.

[4] Lund, J.: Fractures of the Femur—Treatment by the Russell Method of Treatment. Arch. Surg., 23, 889, 1931.

[5] Heller, E. P.: Russell Extension. Jour. Missouri Med. Assn., 28, 266–268, June, 1931.

[6] Chamberlain, D. V.: Improved Apparatus for Russell Traction. Jour. Bone and Joint Surg., 15, 246, 1933.

[7] Eastwood, W. J.: Fracture of the Shaft of the Femur. Brit. Med. Jour., 1, 359, 1933.

[8] Mahorner, H. R., and Bradburn, M.: Fractures of the Femur. Surg., Gynec., and Obstet., 56, 1066, 1933.

[9] Lee, W. E., and Veal, J. R.: The Russell Extension Method in the Treatment of Fractures of the Femur. Surg., Gynec., and Obstet., 56, 492, 1933.

[10] Lowry, T. M.: Physics of Russell Traction. Jour. Bone and Joint Surg., 17, 174–178, January, 1935.

[11] Hambrecht, F. E.: Russell Traction. Jour. Iowa Med. Soc., 25, 496–497, September, 1935.

[12] Gross, H. A.: Russell Treatment. U. S. Naval Med. Bull., 33, 59–64, January, 1935.

[13] Storey, I. C.: Fractures of Shaft of the Femur. Med. Jour. Australia, 2, 675–678, November 24, 1934.

[14] Marians, A.: Form of Balanced Traction—Modification of Russell Traction. Jour. Bone and Joint Surg., 18, 234–235, January, 1936.

[15] Siris, J. E., and Delaney, C. J.: Fractures of Shaft and Neck of Femur—Report of 119 Cases. Amer. Jour. Surg., 32, 277–290, May, 1936.

[16] Sallick, Myron A.: Fractures of the Femur Treated by the Russell Traction Method. Surg., Gynec., and Obstet., 64, 103–109, January, 1937.

[17] Impink, Robert R., and Lee, Walter Estell: Nonoperative Treatment of Fractures of the Shaft of the Femur. Amer. Jour. Surg., 38, 629, 1937.

[18] Sallick, Myron A.: Evaluation of Russell Traction Treatment. Amer. Jour. Surg., 38, 660–666, December, 1937.

[19] Eliason, E. L., and North, John P.: Fractures of the Shaft of the Femur. J.A.M.A., 109, 848–850, September 11, 1937.

[20] Estes, W. J., Jr., and Walker, D. P.: Treatment of Fracture of Shaft of Femur with Special Reference to Russell and Skeletal Traction. Pennsylvania Med. Jour., 41, 1092–1100, September, 1938.

[21] Wilson, Milton J.: Mechanics of Russell Traction. N. Y. Med. Coll.–Flower Hosp. Bull., 1, June, 1938.

[22] Teece, L. G.: Fractures of the Shaft of the Femur. Med. Jour. Australia, 21, 2, 679, 1934.

[23] Van Gorder, G. W.: Fracture of the Shaft of the Femur. Surg., Gynec., and Obstet., 64, 110, 1937.

[24] Weil, G. C., Kuehner, H. G., and Henry, J. P.: The Treatment of 278 Consecutive Fractures of the Femur. Surg., Gynec., and Obstet., 62, 435, 1936.

[25] Strauss, D. C.: Treatment of Fractures of the Femur in Children. Surg. Clin. N. Amer., 15, 555, 1935.

[26] Kennedy, Robert H.: Treatment of Fractures of the Shaft of the Femur. ANNALS OF SURGERY, 107, 419–433, March, 1938.

[27] Blum, L.: ANNALS OF SURGERY, 100, 343, September, 1934.

DISCUSSION.—DR. ROBERT H. KENNEDY (New York) said that in spite of several papers having been published during the past ten years regarding Russell traction, the majority of surgeons are still unaware of its great usefulness, and that Doctor Lewis' paper is particularly valuable because it records his experience and results in by far the largest series yet published. Doctor Kennedy agreed with him in all major points.

In 1932, Doctor Kennedy and his staff at Beekman Street Hospital commenced using Russell traction as the preferred treatment in intertrochanteric and all femoral shaft fractures. In general, it has not been satisfactory in transverse fractures of the middle third and in the lower third fractures with posterior angulation of the distal fragment. In these, open reduction should be performed unless satisfactory position is being maintained at ten days to two weeks after the accident. The danger of overpull in the middle third is great and one-sixteenth inch distraction means many weeks' delay in union.

Russell traction is the best treatment at the present day for intertrochanteric fractures; it usually is efficient in upper third cases, and it is eminently satisfactory in oblique and comminuted fractures of the middle third. Its use for the treatment of a femoral neck fracture is inexcusable.

The method, as is true of all traction, requires the full cooperation of interns, nurses and orderlies. Doctor Kennedy said he mentioned orderlies, in particular, because the use of the bedpan is one of the easiest ways to have traction become disarranged. All must be trained by the visiting staff to know right from wrong and to know how far they can go in adjusting something they find is wrong. Any group of nurses, accustomed to caring for fracture patients treated by different methods, will admit that they prefer attending a case in Russell traction to any other method.

A footpiece should never be a part of the set-up. It subtracts an unknown amount of pull. Doctor Kennedy said he had never seen the slightest loss of any function at the ankle joint with Russell traction continued as long as four months, and that function at knee and hip returns more promptly with this than with other methods.

Manipulation under anesthesia while in traction should be used more frequently. If the desired position has not been attained in 24 to 48 hours such manipulation should be done rather than later.

Before the use of Russell traction, these fractures in children of six to 15 years of age were a source of great worry. Reduction followed by a plaster spica resulted, too frequently, in later slipping with overriding. The child is too large for Bryant traction. Adhesive plaster traction with suspension is not at all satisfactory. One hesitates to put in ice tongs or Steinman pins because of possible interference with the epiphyseal line. Kirschner wires are less dangerous in this regard. Open reduction hardly seems proper, except for muscle interposition, when practically all these fractures heal anyway, but no one likes to care for a case remaining in malposition. Russell traction has happily solved the problem in most instances in these children. Doctor Kennedy could not agree with Doctor Lewis that skeletal traction should be entirely discarded in fractures of the shaft of the femur.

Russell traction is useful for a number of other purposes, *e.g.*, fracture of the acetabulum with or without central displacement of the head of the femur, fracture of the pelvis with displacement of fragments, immobilization following open reduction of fracture of the femur, and immobilization following nailing of the fracture of the neck of the femur.

As used in many hospitals this treatment is merely a name and a travesty on the method suggested by Russell.

DR. A. STILLMAN, 2ND (New York), said that he and the staff at Roosevelt Hospital had been using Russell traction since 1931, having been stimulated to adopt it by Doctor Grace's success at Bellevue. So quickly did the house staff catch on to the principle, and so easy was it to apply, that practically every fractured femur, whether of the neck or shaft, whether old or young, was put up in this traction, and fairly promptly.

With other methods this early application of treatment did not obtain. The use of tongs, pins, wire or even a plaster encasement required the presence of an attending surgeon and this made for delay. With regard to Doctor Lewis' suggestion that the bettering of results in the lower third fractures may be due to the ambulance surgeon's following the dictum of the American College of Surgeons' Fracture Committees to "splint them where they lie," Doctor Stillman said that certainly this earlier treatment in the hospital is one factor. A second factor is the lessened manipulation or monkeying with the fracture after it is put up as compared to other methods. The patient is so comfortable, so relaxed, the reduction is earlier accomplished, and then the patient is let alone. Constant motion at the fracture site is a recognized cause of delay in union.

Of delayed union, Doctor Lewis was fortunate to have none, but it still occurs as evidenced by two cases in recent years at Roosevelt Hospital. One, after 68 days, showed almost no sign of callus, and so a plaster encasement was applied, and after another 60 days was plated, and became solid in seven months. The other case was an upper third fracture in a heavy young man. After Russell traction failed, it was plated, the bone became infected, the plate was removed and now, after two years, is not solid. However, Doctor Lewis' experience must mean that delayed union is less common by the Russell traction method.

In regard to stiffness of the joints, much work must yet be done to accomplish full motion, but the traction pull being through the knee joint capsule gives a better start than in other methods. Doctor Stillman said he had performed one quadriceps extensor lengthening for a stiff knee. The ankle joint does not get stiff because the foot can be, and is, moved by the patient all the time. Doctor Stillman has had little trouble with the hip because, he feared, these patients are gatched-up for their meals. Doctor Lewis warns against this, but does it make an important difference?

Doctor Lewis had 77 intertrochanteric fractures with only five having shortening up to an inch. This is a very good average result. In a small group looked up by Doctor Stillman there were three in 12 cases. This is an older age-group, 72 in Doctor Stillman's series, and four out of 16 died. All six of Doctor Lewis' deaths seem to have been in this group.

Of the shaft, Doctor Lewis showed seven failures, or a little less than 10 per cent, again an exceedingly good record. Out of 12 cases on Doctor Stillman's service, four were plated because of poor position or delayed union—seven had a good result, and one an inch of shortening.

Doctor Lewis has no children under 14 on his service and so this group was not included in his presentation, but Russell traction works exceedingly well with them. Doctor Stillman said he had several times demonstrated the advantage of Russell traction over the Bryant vertical traction to his staff.

As to fractures of the neck of the femur, if Whitman's method of putting these cases up with the thigh extended and internally rotated is right, Russell traction with the thigh flexed and somewhat outwardly rotated must be wrong.

A member of Doctor Stillman's staff looked up these cases and found only one union.

Doctor Stillman concluded that, all-in-all, he favors the Russell traction method and was much indebted to Doctor Lewis for having provided a standard to shoot for.

DR. PHILIP D. WILSON (New York) said that he would always remember having met Mr. Russell, approximately ten years or more ago, at the time no one in this country knew of Russell, or Russell traction. He accompanied Doctor Wilson on his rounds of the Fracture Ward and fell into a discussion with him about treatment of fractures of the shaft of the femur. He asked Doctor Wilson what he was aiming for in the way of alignment, and Doctor Wilson replied that he tried to get as nearly end-to-end approximation as possible. Mr. Russell took the view that it was better to have the fragments in corner-to-corner approximation or even with a little overriding because he had observed that union occurred more quickly and more solidly than with end-to-end approximation. From the functional standpoint, he said that the result was just as good one way as the other and Doctor Wilson had to agree. Mr. Russell then went on, very modestly, to describe the method of traction that he was using. He made a diagram of it and made an analysis of the different forces that were brought to bear upon the fracture by the method of rigging. Doctor Wilson was impressed by the simplicity of the Russell system but it seemed preposterous that a weight of five to ten pounds could be made to do the same work that then required from 35 to 40 pounds of weight when attached to ice tongs or a pin to accomplish. It took several years of observation and experience to find out that all of Russell's claims were true.

Doctor Wilson said, however, that, much as he admired the efficiency and simplicity of Russell traction, he felt it unwise to stress it as the only method of treatment for fractures of the shaft of the femur. His practice is to allow surgeons to choose their own methods while holding them responsible for their results. At a recent meeting of the American Orthopedic Association there was a symposium on "Fracture of the Shaft of the Femur," with 10 or 11 different speakers, and almost everyone advocated a different method of treatment and presented results to substantiate what he claimed. Indications for these different methods of treatment should be formulated and some agreement reached about them.

Doctor Wilson was very much impressed by the results presented by Doctor Lewis but was not sure whether he was talking about end-results, that is, results seen and examined a year or so after discharge from the hospital, or hospital-results, because these are two different matters and analysis some time later will be quite different from that made at the time the patient is discharged from the hospital. The amount of shortening will be greater and there will be bowing and other complications. He asked Doctor Lewis if he would clarify this point, and in concluding complimented Doctor Lewis upon having made an excellent case for Russell traction.

DR. KENNETH M. LEWIS (closing) said that he realized his results with lower third shaft fractures had been better than those reported by Doctor Kennedy. He was unable to account for this unless it was due to the fact that these patients have all been coming into the hospital in Thomas splints with traction applied, the patient having been splinted at the site of the accident. He said he was not giving Russell traction credit for reducing these fractures because they did not have any posterior displacement when they arrived. If one considers, however, the acute angle at which the thigh was usually elevated when skeletal traction was used with a Kirschner wire through the con-

dyles and with the leg frequently acutely flexed on the thigh, one will admit that the muscles were certainly not in a position of physiologic muscle balance. Doctor Lewis said he had often wondered whether the posterior displacement of the lower fragment did not occur when these cases were put up into traction or whether the displacement did not get worse while they were in traction. His results with skeletal traction in the lower third when they had any posterior displacement have been very unsatisfactory.

Doctor Lewis said that when he stated skeletal traction should be discarded in the treatment of fractures of the femur, he realized it was probably too strong a statement to make. On the other hand, one must be guided by his own experience and Doctor Lewis' has been that by using Russell traction routinely the results had been much better. In those cases in which Russell traction does not give an adequate reduction skeletal traction is not even considered, but an open reduction is performed. Fortunately, there have not been any delayed unions in the shaft group.

Regarding end-results, Doctor Lewis said that the results he had reported might be classified as a combination of those cases followed in the wards and in the Follow-Up Clinic, plus those patients cared for while in the hospital but not seen thereafter. Many of the patients at Bellevue Hospital have no homes and so are kept there for relatively long periods of time, until union both by roentgenologic examination and clinically is complete. Thus there is an opportunity for rather long periods of observation and follow-up, even before the patient leaves the hospital. They are not allowed to bear any weight without the aid of an ambulatory splint of one kind or another, unless they are able to handle crutches adequately. Doctor Lewis felt that as far as function in the joints is concerned the results from Russell traction show a big improvement over those with plaster or skeletal traction. Concerning bowing afterwards, it seemed to Doctor Lewis that if there is firm bony callus in a shaft fracture, and that shaft is protected with a walking caliper, and the patient is not allowed to bear any unsupported weight for at least six months, there can be no excuse for the occurrence of bowing. With some of the femur cases, this period of nonweight bearing should be extended to eight or nine months.

TOTAL THYROIDECTOMY FOR HEART DISEASE*

A FIVE-YEAR FOLLOW-UP STUDY

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TOTAL THYROIDECTOMY for heart disease was first performed in 1932. This surgical procedure represented an attempt to bring relief to cardiac derelicts by altering the normal physiologic mechanism. The rationale of this procedure has been repeatedly discussed in publications from this clinic and elsewhere.[5, 11, 12, 19] Numerous reports have presented the immediate and early results, the technic of the procedure, and the fundamental changes which are brought about.[1, 4, 8, 9, 10, 13, 20, 21, 22, 23, 24, 25] Sufficient time has now elapsed since total thyroidectomy for heart disease was first performed for a more considered opinion than has heretofore been available. In this report we are including every patient submitted to total thyroidectomy for heart disease in the Peter Bent Brigham Hospital during 1932, 1933, and 1934. Either the present status or cause of death has been ascertained.

The cases in our study total 57, and have been divided into two fundamental groups: Those (32 patients) with intractable angina pectoris; and those (25 patients) with some form of congestive heart failure which did not yield to the usual conservative measures. Sixteen patients survived a five-year period, 12 in the angina pectoris group and four in the group with congestive failure (Table I); all but one of these were personally examined by us.

TABLE I

MATERIAL

	Number of Operations	Patients Living November, 1939
Angina pectoris	32	12
Congestive failure	25	4
	57	16

Most of the patients who did not survive were closely followed in the hospital dispensary, so that the records show the extent and duration of any improvement that may have taken place after operation. The data concerning the cause of death in the 41 nonsurvivors are based on autopsies in 14 instances, and on observations made in our wards in seven cases where death occurred in this hospital but necropsy was refused. The data on the remaining 20 cases were compiled from letters from attending physicians or death certificates (Table II).

* Read before the American Surgical Association, May 1, 2, 3, 1940, at St. Louis, Mo.

TABLE II

SOURCES OF FOLLOW-UP DATA

	Total No. of Cases
Five-year survivors	16
Office visit	13
Home visit	2
Telephone call	1
Deaths	41
Autopsy	14
Died in P.B.B.H.; autopsy refused	7
Death certificate	11
Letter from family physician or other hospital	9

During the first year following operation 11 of the 25 patients with congestive failure succumbed, in contrast to seven of the 32 with angina pectoris (Table III). In the succeeding years the mortality in each group did not

TABLE III

PERIOD OF POSTOPERATIVE SURVIVAL

	Total Patients	Living at End of 1 Year	2 Years	3 Years	4 Years	5 Years
Angina pectoris	32	25	22	18	15	12
Congestive failure	25	14	11	8	6	4
	57	39	33	26	21	16

exceed four deaths per year. There were five postoperative deaths* in the 57 cases, and all but one, thought to be due to pulmonary embolism, could be directly attributed to heart disease. This mortality rate agrees closely with the operative mortality of 9 per cent reported from the Beth Israel Hospital, Boston, which has had the largest experience with total thyroidectomy for heart disease,[3] but it is somewhat higher than that noted in the collected statistics from other clinics.[13, 21, 24] However, the operative mortality in general is surprisingly low when one considers the poor surgical risks these patients present. As one would expect, nearly all of these patients die eventually from their fundamental cardiac disorder (Table IV). Total

TABLE IV

CAUSES OF DEATH

	Total Deaths	Post-operative	Deaths Attributable to Heart Disease	Other Causes
Angina pectoris	20	3*	16	1 (cerebral hemorrhage)
Congestive failure	21	2‡	17	2 (pneumonia without congestive failure)
	41	5	33	3

* Coronary thrombosis, one day p.o.
Pulmonary edema, one day p.o.
Coronary thrombosis, five days p.o.
‡ Coronary thrombosis, day of operation
Pulmonary embolism, one day p.o.

thyroidectomy should not be regarded as more than a special therapeutic attack upon a group of diseases at present incurable and ultimately fatal.

* In the postoperative death group we include all who died in the hospital within one week of the surgical procedure.

An analysis of the results in each case, on the basis of relief of symptoms, leads to further contrasts between the group with angina pectoris and the group with congestive failure (Tables V, VI, and VII). Despite the small

TABLE V

RELIEF OF PAIN IN ANGINA PECTORIS

A. Patients surviving less than six months		5
B. Patients surviving six months to five years		15
Relief for six months or more	14*	
No relief at six months	1	
C. Patients surviving more than five years		12
Marked and sustained relief (patient's estimate) (substantiated by greater activity and less medication for pain—six)	8	
Temporary relief for six months to two years (degree variable, unimproved at present)	4	
No relief at any time	0	
		32

* In some instances had relief almost to the time of death.

TABLE VI

RELIEF OF CONGESTIVE FAILURE IN CHRONIC RHEUMATIC VALVULAR DISEASE

A. Patients surviving less than six months		5
B. Patients surviving six months to five years		7
Clinical improvement for six months or more (increased activity, fewer symptoms)	5	
No definite improvement	2	
C. Patients surviving more than five years		4
Sustained clinical improvement	1	
Improved for two years	1	
Improved for more than five years, until death from congestive failure	2	
		16

TABLE VII

RELIEF OF CONGESTIVE FAILURE IN ARTERIOSCLEROTIC OR HYPERTENSIVE HEART DISEASE

A. Patients surviving less than six months		5
B. Patients surviving six months to five years		4
Moderate or marked clinical improvement for six months to three and one-half years	3	
No definite improvement	1	
C. Patients surviving for more than five years		0
		9

number of cases certain trends appear clear. In the angina group, with a median age of 61, there are 12 who have survived five years, eight of whom have had sustained clinical improvement. In the congestive failure group, with a median age of 44, only four have survived five years, three of whom have had sustained clinical improvement.* This result is in close accord with the early experiences of other clinics, where the most favorable results have occurred usually in the group with angina pectoris.[13, 21, 24] This may be brought out in another way. Of the 27 patients with angina who lived six months or longer, 26 were at least partially relieved for periods longer than six months. By way of contrast, only 12 of the 15 patients with congestive failure who lived six months or longer were at least partially improved for periods longer than six months.

If the group of patients with congestive failure is subdivided as in Tables VI and VII, one sees an improvement in outlook for those with congestive

* Two of these have died of congestive failure during their sixth postoperative year.

failure from rheumatic valvular disease. However, the slight improvement does not justify much optimism. The median age in this group is 40—20 years less than in the angina group—but the life expectancy in patients with mitral stenosis with marked decompensation is very short. Moreover, it is difficult to evaluate improvement in a group of patients who suffer from recurrent decompensation. Apparent improvement may be merely a natural remission in the disease, and one is less justified in carrying out a radical procedure unless *sustained* improvement is to be expected. We are inclined to be rather pessimistic about the entire congestive failure group. From our small experience with nine cases of congestive failure from arteriosclerotic and hypertensive heart disease, not one of whom survived five years, we feel that total thyroidectomy will give disappointing results if employed here. In the rheumatic group with congestive failure there may be a place for the operation—we have had several cases where we felt there was prolonged and definite benefit—but, unfortunately, there does not appear to be any way to tell in advance which patients will do well. In view of the uncertain benefits and the limited life expectancy, we no longer perform total thyroidectomy for congestive failure.

Our best results from total thyroidectomy have been obtained in the group of patients with intractable angina pectoris. It is admittedly difficult to evaluate improvement in a purely subjective phenomenon like pain, and it is well for us to bear in mind that angina pectoris may undergo remissions and exacerbations like any other chronic disease. It may even cease spontaneously. A well-known tendency under such circumstances is to ascribe the natural improvement to the therapeutic measure employed at the same time. Patients with angina may learn to avoid activities producing pain, and thus bring about fewer attacks. Sometimes the original diagnosis may be in error, as questioned in one of our cases (R. H.). Although our series is numerically small, the relief of pain following total thyroidectomy appears to be beyond question. Every one of our patients, living longer than a few days, had at least temporary improvement. In some cases the relief has been enduring; in others it has lasted only a few months before the reappearance of angina—usually, but not invariably, milder and of a different character. No agreement exists as to the mechanism by which relief is obtained.

The question is raised whether life is prolonged in patients relieved of their pain by total thyroidectomy. Since the prognosis for life varies so widely, a much larger series of cases than is included in the present study will be required to settle the problem. In one recent study of prognosis in angina pectoris the duration of life varied from one month to 23 years after the onset of symptoms.[15] In this same study no signficant change in prognosis could be demonstrated between those who had angina decubitus and those who had it only on effort. In the much more serious group, who have had coronary thrombosis, Dublin[14] cites statistics from several sources showing that patients surviving a first attack may live for years; 28 per

cent in one series survived five years or longer, 20 per cent in another. Our small series is without statistical significance on this point.

It is likewise difficult to select patients who are suitable for total thyroidectomy in the angina pectoris group. Patients making up this series were selected largely on the basis of intractability of pain to ordinary therapeutic measures. Many of them had angina decubitus (ref. Case summaries). No patient in the group of 12 five-year survivors had frank signs and symptoms of congestive failure before operation, while six in the group of 20 who did not survive gave definite evidence of congestive failure. Three of the five-year survivors had some cardiac enlargement before operation—in two it was only slight. Ten of the nonsurvivors had cardiac enlargement—in six this was slight. From this it would appear that either congestive failure or cardiac enlargement is an unfavorable prognostic sign. Interestingly enough, a previous coronary thrombosis does not seem to affect the prognosis adversely.

It is noteworthy that in the five-year follow-up the problem of myxedema in these thyroidectomized cardiacs does not loom large. In no instance in the entire series has myxedema offered a problem comparable to the heart disease for which operation was undertaken. Several patients (S. G., with spontaneous myxedema before operation, and G. S., who was psychotic and uncooperative) have offered considerable difficulty; the remainder, however, almost without exception have proved amenable to management. The case summaries of the survivors and the photographs bear out this point. Nearly all of the surviving patients feel the cold easily, and some of them speak slowly. Although most of them believe they are slowed down mentally, we have difficulty in attributing this possible change to the imposed myxedema but see in it rather the normal slowing down with age. As can be seen in the case summaries, there is considerable variation in the amount of thyroid taken by different patients. We regard these patients, like diabetics, as continuous problems in management, and an effort is made to explain this to them, to see them at regular intervals, to check the basal metabolic rate as needed, and to adjust the dosage of thyroid to the optimum for each individual patient. Should the basal metabolic rate become elevated, there may be a recurrence of angina symptoms. It is very important to bear in mind not only that the optimum dose of thyroid extract may vary with each patient but also that in any individual this requirement may vary from time to time. In our experience a basal metabolic rate of about −15 was satisfactory in the majority of patients, but as the case summaries reveal this level cannot be utilized as the optimum level for all patients. Our experience agrees with others, that surgical myxedema need not interfere too much with the patient's enjoyment of life nor become a serious problem in control.[3, 10, 13]

SUMMARY AND CONCLUSIONS

We are able, at this time, to report a five-year follow-up of 57 consecutive cases of total thyroidectomy performed for heart disease during 1932, 1933,

FIG. 1.



FIG. 2.





FIG. 3A.

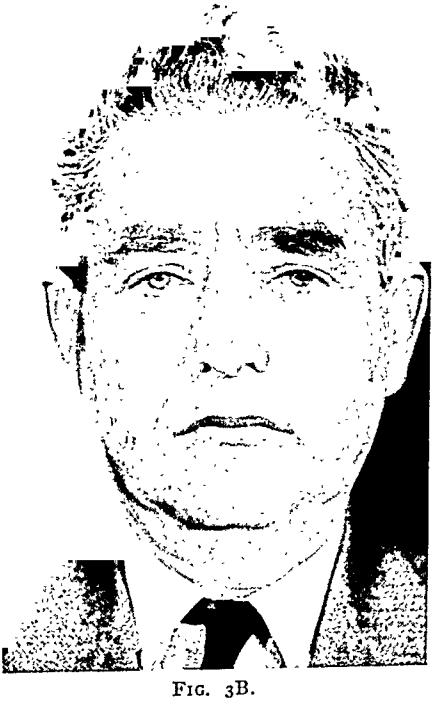


FIG. 3B.

FIG. 1.—M. G., age 61. November, 1939. Six years and two months after operation. B.M.R. +5.

FIG. 2.—W. D., age 60. November, 1939. Five years and 10 months after operation. B.M.R. −11.

FIG. 3A.—B. F., age 50. April, 1934. Before operation. B.M.R. +13.

FIG. 3B.—B. F., age 55. November, 1939. Five years and seven months after operation. B.M.R. −14.

FIG. 4.



FIG. 5A.



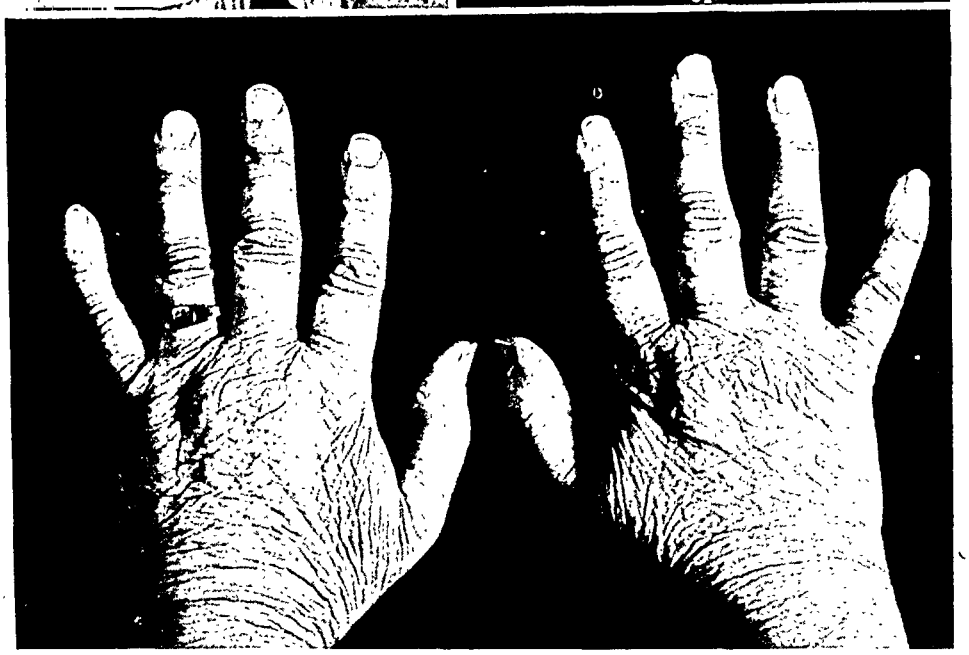


FIG. 5B.

FIG. 4.—H. Z., age 61. December, 1939. Five years and nine months after operation. B.M.R. −15.

FIG. 5A and B.—S. G., age 55. November, 1939. Five years and seven months after operation. B.M.R. −16. Spontaneous myxedema preceded operation.

FIG. 6.

FIG. 7.







FIG. 8A.



FIG. 8B.

FIG. 6.—Z. K., age 68. November, 1939. Five years and five months after operation. B.M.R. −7.

FIG. 7.—H. B., age 62. December, 1939. Five years and three months after operation. B.M.R. −16.

FIG. 8A.—L. B., age 43. 1927. Seven years before operation.

FIG. 8B.—L. B., age 53. September, 1937. Three years and six months after operation. B.M.R. −15.

FIG. 9.

FIG. 10.



FIG. 11.

FIG. 12.

FIG. 9.—C. C., age 39. December, 1939. Six years and two months after operation. B.M.R. −21.

FIG. 10.—A. P., age 49. November, 1939. Five years and 10 months after operation. B.M.R. −28.

FIG. 11.—M. A., age 40. December, 1939. Five years and eight months after operation. B.M.R. −26.

FIG. 12.—S. B., age 35. December, 1939. Five years and seven months after operation. B.M.R. −20.

TABLE VIII

CASE SUMMARIES

ANGINA PECTORIS—FIVE-YEAR SURVIVORS—12 CASES

Case	Age and Sex	Preoperative: Duration of Symptoms	Preoperative: Coronary Thrombosis	Date of Operation	Date of Follow-Up	Postoperative Survival		Symptoms	Cardiovascular Status*: Cardiac Enlargement	Blood Pressure	Congestive Failure: Symptoms	Congestive Failure: Signs	Vital Capacity	B.M.R.	Medication: Nitroglycerin	Medication: Digitalis	Medication: Thyroid†	Myxedema	Comment
M. P.	60 F.	8 yrs.	No	8–22–33	4–20–40 Home visit	6 yrs., 7 mos.	Pre-op.	Averages 2 attacks daily, on bed and chair existence. Slight effort brings on pain.	No	175/ 70	Mild	Mild	2,200 cc.	+9	Yes	No	No	Feels cold easily. Is normal mentally but feels "slowed down."	Improved by operation for 1–2 yrs., but not now. Daughter says patient is "much better since operation but won't admit it." Has developed evidence of marked hypertension and congestive failure. A partial success.
							5 yrs.+	Bed and chair existence. Still occasional pain. Climbs 2 flights once a day	Yes	260/110	Yes	Yes	?	−15 (1935)	1–2 daily	0.1 Gm. daily	15 mg. every 2 days		
M. G.	55 M.	4 yrs.	No	9–22–33	11–27–39 Office visit	6 yrs., 2 mos.	Pre-op.	Greatly restricted activity. 1–3 attacks daily. A few steps may bring on severe pain.	No	150/ 90	Sl.	No	2,600 cc.	+7	Up to 100 a week	No	No	Mild symptoms. Feels cold easily. May have slight retardation of memory	Definitely improved by operation. Greater activity; less pain; practically no nitroglycerin. Is developing congestive failure. A good result
							5 yrs.+	Slight pain 1–2 times daily, not as severe as before operation. Climbs 2 flights twice daily slowly.	Yes	210/110	Mod.	Mod.	2,800 cc.	+5	One a month	0.1 Gm. daily	15 mg. daily		
R. H.	42 M.	21 yrs.	No	10–17–33	12–12–39 Office visit	6 yrs., 1 mo.	Pre-op.	An active clerk. Up to 20 attacks of numbness and oppression in chest daily; wide radiation. Previous bilateral cervical sympathectomy without relief.	No	160/ 90	No	No	3,500 cc.	−12	20 a day	No	No	Mild myxedema with thickened speech and subjective "poor concentration."	Improved by operation in some respects, not in others. Objectively no change. Obscure case with angina at a very early age and no bad consequences. Diagnosis may be in error. A poor result.
							5 yrs.+	Unchanged. Still at work. Still 20 attacks daily.	No	130/95	No	No	3,000 cc.	−27	20 a day	No	30 mg. daily		
J. S.	61 F.	5 yrs.	? mild attack in 1928	11– 1–33	5–17–40 Office visit	6 yrs., 6 mos.	Pre-op.	Moderately restricted activity. Attacks even at rest.	Sl.	140/ 70	No	No	3,000 cc.	−7	One or more daily	No	No	Mild symptoms. "Brain doesn't work as it should," but she worries less.	"100 per cent improved. Better than 10 years ago." Fairly active woman. Is developing evidence of hypertension and congestive failure. A good result.
							5 yrs.+	Rare attacks, usually in bed. May be free from pain for weeks. Avoids strains. Travels. Climbs 1 flight daily.	Sl.	220/110	Sl.	Mod.	2,400 cc.	−7	One a month	0.1 Gm. daily	30 mg. 5 times weekly		
G. S.	66 M.	10 yrs.	No	11–13–33	4–18–40 Phone	6 yrs., 5 mos.	Pre-op.	Attacks even at rest, requiring up to 30 nitroglycerin pills daily.	No	150/ 90	Sl.	No	2,100 cc.	−4	20–30 daily	No	No	At one time had marked myxedema. Not seen recently. Psychotic and uncooperative.	Had temporary relief for some months. Hard to appraise now, but evidently unsatisfactory. A poor result.
							5 yrs.+	Markedly psychotic. Takes many pills. Complains of severe pain.							20–30 daily	—	45 mg. daily		
W. D.	54 M	8 yrs	No	1–17–34	11–28–39 Office visit	5 yrs., 10 mos.	Pre-op.	2–3 attacks daily, occasionally at rest. Restricted to house.	No	130/ 85	No	No	3,550 cc.	−3	Yes	No	No	Feels cold easily. No mental symptoms.	Very much improved by operation. A good result.
							5 yrs.+	Mild substernal distress every 2–3 days. Less severe than before operation. Drives a car.	No	120/ 80	No	No	3,200 cc.	−11	No	No	15 mg. twice weekly		
H. Z.	56 M.	4 yrs.	1930	3– 5–34	12– 9–39 Office visit	5 yrs., 9 mos.	Pre-op.	Attacks of short duration and only upon effort. Can walk 1 block.	Sl.	145/ 85	Sl.	No	2,600 cc.	−4	Yes	Yes	No	Only slightly diminished speed of cerebration.	Feels improved by operation. Now, 5 years later, not much better than previously, but has had 4 years of sustained relief. Fatigues easily. Is developing congestive failure. A good result.
							5 yrs.+	Some recurrence of pain after 4 years of freedom. Activity restricted.	Yes	108/ 76	Yes	Yes	2,300 cc.	−15	2–8 daily	0.1 Gm. daily	15 mg. daily		
A. K.	72 M	7 mos.	No	3– 6–34	4–20–40 Home visit	6 yrs., 1 mo.	Pre-op.	Severe and prolonged pain even at rest. Not greatly relieved by nitrites.	No	160/ 85	No	No	2,300 cc.	−1	Amyl nitrite	No	No	Moderate myxedema. Slow speech, but alert mentally. Feels cold easily.	A feeble man, age 78, who was regarded as a dubious case for operation. Very emphatic about the good results of operation and permanent relief from terrific pain. Is developing congestive failure. A good result as regards pain.
							5 yrs.+	No pain since operation, although "tiredness" in arms. Bed and chair existence.	No	220/105	Yes	Yes			No	No	No		

B. F.	50 M.	3 mos.	No	4-23-34	11-28-39 Office visit	5 yrs., 7 mos.	Pre-op.	Several attacks daily even at rest. Confined to house.	No	150/ 86	Sl.	Sl.	2,400 cc.	+13	2-3 daily	No	No	Somewhat slowed mentally.	Feels greatly improved by operation. A good result.
							5 yrs.+	Rare pain, in winter only. Climbs 2-3 flights slowly. Drives a car, but not in traffic.	No	140/ 85	Sl.	No	2,800 cc.	−14	9 pills in 5 months	No	15 mg. daily		
S. G.	50 F	3 yrs.	1931	4-27-34	11-29-39 Office visit	5 yrs., 7 mos.	Pre-op.	Spontaneous myxedema, 12 yrs. Mild angina. 1 flight produces pain.	Yes	170/ 75	Mod.	Sl.	1,600 cc.	−25	Yes	Yes	15 mg. daily	Rather marked myxedema with slow speech, *etc.*	Complicated by spontaneous myxedema. Felt improved for several years after operation, but not now. A partial success.
							5 yrs.+	Relief from pain for 1-2 yrs. Attacks now up to 4 times daily. Does light housework.	Yes	195/ 85	Mod.	Mod.	1,600 cc.	−16	Four times a day	Off and on	15 mg. daily		
Z. K.	63 M.	7 mos.	No	6-25-34	11-24-39 Office visit	5 yrs., 5 mos.	Pre-op.	Up to 10 attacks daily even at rest.	No	140/ 90	Sl.	No	—	−10	Yes	No	No	Thinks cerebration slowed.	Improved by operation. A good result.
							5 yrs.+	Very rare pain. Can walk 10 blocks. Feels quite comfortable.	No	120/ 80	Sl.	No	2,500 cc.	−7	No	0.1 Gm. daily	15 mg. daily		
H. B.	57 M.	4 yrs.	1930	8-27-34	12- 5-39 Office visit	5 yrs., 3 mos.	Pre-op.	1-2 attacks daily even at rest. Bed rest most of the day.	No	120/ 75	No	Sl.	2,900 cc.	−5	1-2 daily	No	No	No symptoms.	Very much improved. A good result.
							5 yrs.+	Rare and moderate substernal pain on effort. 1 flight twice a day. Can walk a mile.	? sl.	128/ 90	No	Sl.	3,350 cc.	−16	2-3 a year	No	15 mg. every 2 days		

* No auricular fibrillation in any case. † The figures for thyroid intake were taken from our last follow-up visit and do not represent the continuous requirement of thyroid extract which must be frequently adjusted.

TABLE IX

CASE SUMMARIES

ANGINA PECTORIS—20 DEATHS

					Preoperative Cardiovascular Status*									
Case	Age and Sex	Preoperative Duration of Symptoms	Date of Operation	Symptoms	Preoperative Coronary Thrombosis	Cardiac Enlargement	Blood Pressure	Congestive Failure: Symptoms	Congestive Failure: Signs	Cause of Death	Date of Death	Postoperative Survival	Duration of Postoperative Improvement	Comment
D. G.	43 M.	9 yrs.	12-14-32	Attacks with slightest effort, requiring up to 20 nitroglycerin tablets daily.	No	Yes	165/110	Yes	Yes	Generalized thromboangiitis obliterans. (autopsy)	9- 7-33	8 mos.	7 mos.	Free from pain for 7 months, although congestive failure was not much influenced.
A. R.	61 F.	3 yrs.	2- 4-33	3-4 attacks daily, even at rest. Bed and chair existence.	1931	Sl.	190/100	Yes	Yes	Coronary thrombosis. (autopsy)	9-18-35	2 yrs., 7 mos.	1 yr., 3 mos.	Moderately severe recurrent angina after 15 months of definite relief.
A. H.	59 M.	2 yrs.	7- 8-33	5-6 severe attacks daily, even at rest.	No	Yes	140/ 45	Yes	Yes	Acute pulmonary edema. (letter)	7-26-33	18 days	—	Only case in series with angina from syphilitic aortitis.
A. P.	58 M.	3 yrs.	9-21-33	2-4 attacks daily from slightest effort.	1931 and 1932	No	145/ 80	No	No	Old coronary sclerosis. Congestive failure. (autopsy)	4- 1-38	4 yrs., 6 mos.	3 yrs.	Recurrent angina after 3 years of relief. Coronary thrombosis twice after operation.
I. S.	64 M.	3 yrs.	9-29-33	3-4 severe attacks weekly, even at rest.	1931	No	140/ 85	Yes	Yes	Coronary thrombosis. (autopsy)	7-11-34	9 mos.	7 mos.	Complicated by mild diabetes. Definite improvement for at least 7 months, although still mild distress.
M. K.	60 F.	9 mos.	10-25-33	Frequent attacks, even at rest.	Sept. 1933	Sl.	140/ 80	Mild	Mild	Sudden death in chair. (death certificate)	8-21-37	3 yrs., 9 mos.	1 yr., 3 mos.	After 15 months of great subjective and objective relief recurrent angina and progressive congestive failure developed.
J. M.	52 F.	5 yrs.	10-26-33	Frequent attacks, even on bed rest.	1931 and Aug. 1933	Yes	140/100	Yes	Yes	"Myocarditis" and congestive failure. (death certificate)	4-25-35	1 yr., 6 mos.	1 yr., 4 mos.	Relief from pain for at least 16 months. No effect on congestive failure.
B. A.	61 M.	2 yrs.	10-28-33	Frequent attacks, with slightest effort.	No	Yes	120/ 90	No	No	Pulmonary edema. (coroner)	1-12-38	4 yrs., 2 mos.	2 yrs., 10 mos.	Definite relief for 2 years 10 months. Some recurrent angina after 4 years.
O. H.	68 M.	2 yrs.	10-28-33	Severe attacks, even with the slightest effort.	? Mild attack, 4 months before operation.	No	145/ 90	No	No	Chronic myocarditis. (death certificate)	10- 5-36	2 yrs., 11 mos.	1 yr., 6 mos.	Complicated by mild diabetes. Definite relief for at least 18 months, although recurrent, but atypical, angina 2½ years later.
K. W.	65 F.	12 yrs.	11- 2-33	Up to 15 attacks daily, even at rest.	No	Sl.	190/ 90	No	No	Coronary thrombosis. (death certificate)	2-17-35	1 yr., 3 mos.	6 mos.	Considerable improvement for at least 6 months, although continued nitroglycerin. Recurrent angina after 1 year.

TABLE IX (Continued)

CASE SUMMARIES

ANGINA PECTORIS—20 DEATHS

Case	Age and Sex	Preoperative Duration of Symptoms	Date of Operation	Symptoms	Preoperative Cardiovascular Status*					Cause of Death	Date of Death	Postoperative Survival	Duration of Postoperative Improvement	Comment
					Preoperative Coronary Thrombosis	Cardiac Enlargement	Blood Pressure	Congestive Failure: Symptoms	Congestive Failure: Signs					
W. S.	67 M.	10 mos.	11–22–33	Frequent and severe attacks, even at rest.	No	No	140/ 80	No	No	Coronary thrombosis. (autopsy)	11–27–33	5 days	—	Postoperative death.
I. C.	65 F.	8 mos.	11–24–33	Up to 20 severe attacks daily, even at rest.	? mild attack, 8 months before operation.	No	160/ 80	No	No	Congestive failure. (death certificate)	10–25–37	3 yrs., 10 mos.	3 yrs., 5 mos.	Complete relief from pain for at least 3 years, 5 months.
C. W.	53 M.	5 yrs.	12– 7–33	Attacks requiring up to 10 nitroglycerin tablets daily, even at rest.	1932	No	110/ 70	No	No	Coronary thrombosis. (autopsy)	4– 2–34	3 mos.	1 mo.	Recurrent angina after complete relief for 1 month.
N. N.	61 M.	12 yrs.	12– 8–33	Many attacks daily, even at rest.	? attack in 1927	No	220/110	Yes	No	Cerebral hemorrhage. (death certificate)	8– 9–38	4 yrs., 8 mos.	2 yrs.	Intermittent fibrillation. Symptoms from tetany. Recurrent angina after 2 years of definite improvement.
W. R.	65 M.	1 yr.	12–13–33	1–4 attacks daily, usually at night.	No	No	120/ 80	No	No	Congestive failure. (death certificate)	2–16–36	2 yrs., 8 mos.	1 yr., 2 mos.	Occasional fleeting pains, but definite relief for at least 14 months. Some symptoms from myxedema.
E. L.	67 F.	7 yrs.	12–13–33	4–10 attacks daily, even at rest.	—	Sl.	140/ 70	No	No	Coronary thrombosis. (autopsy)	12–14–33	1 day	—	Postoperative death.
S. S.	62 F.	1 yr.	1– 4–34	4–6 attacks daily, even at rest.	No	Sl.	165/ 95	Sl.	Yes	Pulmonary edema. (hospital—no autopsy)	1– 5–34	1 day	—	Complicated by mild diabetes. Postoperative death.
L. S.	64 F.	3 yrs.	1–20–34	Frequent attacks. Bed rest for 2 yrs.	No	No	220/130	? no	No	Coronary thrombosis. (letter)	2– 5–35	1 yr.	9 mos.	Definite relief from pain, but marked discomfort from myxedema.
L. B.	50 M.	4 yrs.	3–21–34	3 attacks daily.	4 months before operation.	No	110/ 65	Yes	No	Coronary thrombosis. (autopsy)	1– 2–38	3 yrs., 9 mos.	3 yrs., 6 mos.	Marked and sustained relief, practically to time of death.
E. S.	65 F.	3 yrs.	4–12–34	Constant precordial pressure and frequent sharp attacks.	No	Sl.	130/ 80	Yes	No	"Myocarditis." (death certificate)	1–13–37	2 yrs., 9 mos.	3 mos.	Complicated by recurrent hyperthyroidism. Subtotal thyroidectomy in 1931, with relief for 2 years. Following total thyroidectomy no definite relief after 3 months. Definite symptoms by 11 months.

* Only one case had auricular fibrillation (N. N.).

TABLE X

CASE SUMMARIES

CONGESTIVE FAILURE IN CHRONIC RHEUMATIC VALVULAR DISEASE—16 CASES

Case	Age and Sex	Preoperative Duration of Symptoms	Date of Operation	Symptoms	Preoperative Cardiovascular Status†				Cause of Death	Date of Death	Postoperative Survival	Duration of Postoperative Improvement	Comment
					Cardiac Diagnosis*	Auricular Fibrillation	Blood Pressure	Vital Capacity‡					
B. M.	41 F.	23 yrs.	4– 7–33	Recurrent decompensation.	MS & MI. Calcified pericardium	Yes	145–110	1,100 cc.	Congestive failure. (autopsy)	10–17–35	2 yrs., 6 mos.	7 mos.	Definitely, although temporarily, relieved. Frequent postoperative hospitalization for decompensation.
F. R.	53 M.	9 yrs.	5–19–33	Recurrent decompensation.	MS & MI	Yes	210/ 68	1,650 cc.	Congestive failure. (autopsy)	10– 8–33	4 mos.	—	
S. P.	45 M.	2 yrs.	5–26–33	Recurrent ascites (10 paracenteses).	MS & MI. Adherent pericardium	Yes	120/ 70	2,100 cc.	Postoperative death, after pericardiectomy. (hospital—no autopsy)	7–22–33	1 mo.	—	Pericardiectomy in this hospital.
D. W.	28 F.	8 yrs.	6– 5–33	Recurrent decompensation.	MS & MI	No	170/ 85	1,800 cc.	Congestive failure. (letter from physician)	3–21–34	9 mos.	6 mos.	Questionably improved for 6 months, then progressive failure. Markedly psychotic after operation.
C. C.	33 M.	5 mos.	10–16–33	Progressive severe decompensation.	MS & MI	Yes	140/ 90	2,000 cc.	Congestive failure. (hospital—no autopsy) 5-year survival.	6–21–40	6 yrs., 8 mos.	6 yrs.+	Improved subjectively and objectively, although numerous hospital admissions for mild decompensation.
E. F.	54 M.	12 yrs.	12– 6–33	Severe dyspnea without right ventricular failure.	MS & MI	Yes	140/ 80	2,000 cc.	Congestive failure. (hospital—no autopsy)	12– 1–38	4 yrs., 11 mos.	4 yrs.+	Excellent result until terminal illness.
P. R.	39 F.	11 yrs.	1–27–34	Recurrent decompensation.	MS & MI	Yes	125/ 90	2,100 cc.	Congestive failure. (autopsy)	11–29–38	4 yrs., 10 mos.	2 yrs.+	Moderate improvement for at least 2 years.

F. M.	50 M.	10 yrs.	2- 8-34	Recurrent decompensation.	MS	Yes	110/ 80	1,200 cc.	Congestive failure. (autopsy)	4-21-35	1 yr., 2 mos.	2 mos.	Progressive failure after short improvement.	
A. P.	44 M.	7 yrs.	2-12-34	Progressive decompensation.	MS	Yes	140/ 80	2,200 cc.	Living Dec., 1939. 5-year survival.	—	5 yrs., 10 mos.	5 yrs.+	Improved subjectively and objectively. Can climb 2 flights. Vital capacity 2,100 cc. B.M.R.—28 on 15 mg. thyroid a day. Moderate myxedema.	
S. C.	30 F.	8 yrs.	2-13-34	Recurrent decompensation.	MS, MI, AS & AI	No	110/ 70	1,700 cc.	Congestive failure. (hospital —no autopsy)	2- 7-37	2 yrs., 11 mos.	2 yrs.+	Fairly well for over 2 years. Then gradual failure.	
L. A.	24 M.	22 yrs.	4-23-34	Recurrent decompensation.	MS, MI & AI	Yes	140/ 60	1,350 cc.	Congestive failure. (death certificate)	8-26-34	4 mos.	—	Unimproved. A cardiac from the age of 2.	
M. A.	35 F.	17 yrs.	4-25-34	Recurrent severe decompensation—6 months. Milder symptoms for a long time.	MS & MI	Yes	150/ 90	2,100 cc.	Living Dec., 1939. 5-year survival.	—	5 yrs., 8 mos.	2 yrs.+	Markedly improved for 2 years. Can walk 1 block. Can climb 1 flight. Vital capacity 1,600 cc. B.M.R. —26 on 15 mg. thyroid a day. No myxedema.	
S. B.	30 M.	15 yrs.	5-26-34	Recurrent decompensation.	MS & AI	No	130/ 90	1,800 cc.	Congestive failure and pulmonary embolism. (hospital —no autopsy) 5-year survival.	2-27-40	5 yrs., 9 mos.	5 yrs.+	Definitely improved until terminal illness. Worked intermittently. Climbed 1 flight.	
H. B.	46 F.	6 yrs.	6- 2-34	Recurrent decompensation. Bed rest for 4 months.	MS & MI	Yes	204/140	1,200 cc.	Sudden death. ? pulmonary embolism. (hospital—no autopsy)	6- 3-34	1 day	—	Postoperative death.	
M. B.	50 M.	6 mos.	8- 1-34	Progressive decompensation.	MS	Yes	186/134	1,100 cc.	Slow coronary closure. (letter from physician)	4-23-37	2 yrs., 8 mos.	2 yrs.+	Some improvement for 2 years.	
E. P.	31 F.	13 yrs.	12-12-34	Recurrent decompensation.	MS, MI, AS & AI	No	150/ 60	2,400 cc.	Cerebral emboli. (hospital— no autopsy)	2- 8-35	1 mo.	—	Decompensation improved after operation.	

* MS—mitral stenosis. MI—mitral insufficiency. AS—aortic stenosis. AI—aortic insufficiency.
† Cardiac enlargement and evidence of congestive failure in all 16 cases.
‡ The vital capacity reading is the one just before operation, and may have been lower earlier.

TABLE XI

CASE SUMMARIES

CONGESTIVE FAILURE IN ARTERIOSCLEROTIC OR HYPERTENSIVE HEART DISEASE—9 CASES

Case	Age and Sex	Preoperative Duration of Symptoms	Date of Operation	Symptoms	Preoperative Cardiovascular Status* Cardiac Diagnosis	Auricular Fibrillation	Blood Pressure	Vital Capacity†	Cause of Death	Date of Death	Postoperative Survival	Duration of Postoperative Improvement	Comment
R. M.	61 M.	4 yrs.	3- 9-33	Severe decompensation.	Chronic myocarditis	Yes	136/ 90	1,950 cc.	Chronic myocarditis heart block. (hospital—no autopsy)	8-27-33	5 mos.	3 mos.	Postoperative death. A desperate case.
G. C.	70 M.	13 yrs.	4-11-33	Coronary thrombosis, with progressive decompensation—2½ weeks.	Chronic myocarditis. Coronary sclerosis	No	156/ 88	1,200 cc.	Coronary thrombosis and congestive failure. (autopsy)	4-11-33	..	—	Postoperative death. A desperate case.
L. W.	48 M.	4 yrs.	8- 3-33	Recurrent decompensation. Some chest pain.	Chronic myocarditis	Yes	190/ 96	2,250 cc.	Lobar pneumonia. No cardiac failure. (autopsy)	June, 1937	3 yrs., 10 mos.	3 yrs.+	Improved until death from another cause. Best result in this group.
H. E.	40 M.	5 yrs.	1-13-34	Severe decompensation. Bed rest for 4 months.	Chronic myocarditis	No	120/ 80	1,700 cc.	Pulmonary edema. (hospital letter)	2-16-34	1 mo.	—	
P. S.	50 F.	4 yrs.	2- 1-34	Recurrent decompensation.	Chronic myocarditis	No	174/110	1,750 cc.	"Chronic interstitial nephritis." Chronic myocarditis. (death certificate)	5-23-35	1 yr., 3 mos.	2 mos.	Slight improvement. Only follow-up contact 2 months after operation.
O. McG.	50 M.	5 yrs.	6-25-34	Severe dyspnea. Bed rest for 6 weeks.	Hypertensive cardiovascular disease	No	170/120	1,600 cc.	"Arteriosclerosis. Chronic nephritis and uremia." (death certificate)	1-21-36	1 yr., 7 mos.	6 mos.	Temporary relief in a previously bed-ridden man.
H. W.	56 M.	3 yrs.	7-19-34	Progressive decompensation.	Chronic myocarditis. Coronary disease	No	125/ 70	2,000 cc.	Congestive failure. (letter from physician)	10-15-34	2 mos.	—	Unimproved. Not much cardiac enlargement.
M. K.	37 M.	6 mos.	8- 9-34	Progressive decompensation.	Hypertensive vascular disease. Nephrosclerosis	No	240/150	—	Bronchial pneumonia. No cardiac failure. (letter from physician)	9-23-34	1 mo.	—	
S. L.	36 M.	6 mos.	8-15-34	Dyspnea and constant precordial tightness.	Hypertensive cardiovascular disease	No	210/ 80	1,200 cc.	Congestive failure. (letter from wife)	2-28-39	4 yrs., 6 mos.	2 yrs., 6 mos.	Definite improvement for 2½ years, although somewhat troubled by myxedema. Last follow-up April, 1937.

* Cardiac enlargement (slight only in H. W.) and evidence of congestive failure in all cases.
† The vital capacity reading is the one just before operation, and may have been lower earlier.

and 1934. The majority of the patients had been unrelieved by medical therapy and presented a serious operative risk. There were 12 survivors in the group of 32 with angina pectoris, and four survivors in the group of 25 who had congestive failure. There were five postoperative deaths; four of these, as well as all but three of the later deaths, were attributable to heart disease.

The best results were obtained in patients with angina pectoris. Twenty-six of the 27 patients surviving more than six months were relieved of pain in some degree for six months or longer, and eight of the 12 five-year survivors had sustained relief. In this group it was noted that preoperative evidence of congestive failure or cardiac enlargement was an unfavorable prognostic sign for long survival.

In the patients with congestive failure the five-year results were disappointing. Fifteen of the 25 patients lived for six months or more, and 12 of these had relief for six months or longer. There were four five-year survivors, three showing sustained relief; two of these three have died of congestive failure in the sixth year after operation. Results were better in the group having congestive failure from chronic rheumatic valvular disease than from arteriosclerotic or hypertensive heart disease.

We conclude that in a selected group of patients with intractable angina pectoris, total thyroidectomy is a worth while therapeutic measure, and is without unwarranted risk.

BIBLIOGRAPHY

[1] Berlin, D. D.: Total Thyroidectomy for Intractable Heart Disease. J.A.M.A., **105**, 1104–1107, 1935.

[2] Berlin, D. D., Blumgart, H. L., Weinstein, A. A., Riseman, J. E. F., and Davis, D.: Treatment of Angina Pectoris and Congestive Failure by Total Ablation of the Normal Thyroid. New Eng. Jour. Med., **211**, 863–868, 1934.

[3] Blumgart, H. L.: Total Thyroidectomy for the Relief of Cardiac Pain and Congestive Heart Failure. Diseases of the Coronary Arteries and Cardiac Pain, ed. by Robert L. Levy. Chapter XVI. New York, 1936, The Macmillan Company.

[4] Blumgart, H. L., Berlin, D. D., Davis, D., Riseman, J. E. F., and Weinstein, A. A.: Treatment of Angina Pectoris and Congestive Failure by Total Ablation of Thyroid. J.A.M.A., **104**, 17–26, 1935.

[5] Blumgart, H. L., Levine, S. A., and Berlin, D. D.: Congestive Heart Failure and Angina Pectoris. The Therapeutic Effect of Thyroidectomy on Patients without Clinical or Pathologic Evidence of Thyroid Toxicity. Arch. Int. Med., **51**, 866–877, 1933.

[6] Blumgart, H. L., Riseman, J. E. F., Davis, D., and Berlin, D. D.: Therapeutic Effect of Total Ablation of Normal Thyroid on Congestive Heart Failure and Angina Pectoris. Arch. Int. Med., **52**, 165–225, 1933.

[7] Blumgart, H. L., Riseman, J. E. F., Davis, D., and Weinstein, A. A.: Treatment of Angina Pectoris and Congestive Failure by Total Ablation of the Normal Thyroid. Am. Heart Jour., **10**, 596–604, 1935.

[8] Bourne, G., and Ross, J. P.: Thyroidectomy for the Relief of Cardiac Pain. Lancet, **2**, 815–817, 1938.

[9] Claiborne, T. S., and Hurxthal, L. M.: Results of Total Thyroidectomy in Heart Disease. New Eng. Jour. Med., **216**, 411–417, 1937.

[10] Clark, R. J., Means, J. H., and Sprague, H. B.: Total Thyroidectomy for Heart Disease. New Eng. Jour. Med., 214, 277–295, 1936.

[11] Cutler, E. C.: Total Thyroidectomy for Heart Disease. Minn. Med., 18, 421–436, 1935.

[12] Cutler, E. C., and Schnitker, M. T.: Total Thyroidectomy for Angina Pectoris. ANNALS OF SURGERY, 100, 578–605, 1934.

[13] Dinnerstein, M., Weeks, C., Woodruff, I. O., and Tilley, A. R.: Total Thyroidectomy in Angina Pectoris and Congestive Failure. Am. Jour. Surg., 36, 421–442, 1937.

[14] Dublin, L. I.: Statistics of Diseases of the Coronary Arteries. Diseases of the Coronary Arteries and Cardiac Pain, ed. by Robert L. Levy. Chapter VII. New York, 1936, The Macmillan Company.

[15] Eppinger, E. C., and Levine, S. A.: Angina Pectoris: Some Clinical Considerations with Special Reference to Prognosis. Arch. Int. Med., 53, 120–130, 1934.

[16] Gilligan, D. R., Volk, M. C., Davis, D., and Blumgart, H. L.: Therapeutic Effect of Total Ablation of Normal Thyroid on Congestive Heart Failure and Angina Pectoris. Arch. Int. Med., 54, 746–757, 1934.

[17] Hertzler, A.: Evaluating the Results of Total Thyroidectomy in Cardiac Disturbances. Am. Jour. Surg., 29, 342, 1935.

[18] Kennedy, W. R.: The Treatment of Congestive Heart Failure and Angina Pectoris by the Complete Removal of the Normal Thyroid Gland. Canad. Med. Assn. Jour., 30, 610–614, 1934.

[19] Levine, S. A., Cutler, E. C., and Eppinger, E. C.: Thyroidectomy in the Treatment of Advanced Congestive Heart Failure and Angina Pectoris. New Eng. Jour. Med., 209, 667–679, 1933.

[20] Levine, S. A., and Eppinger, E. C.: Further Experiences with Total Thyroidectomy in the Treatment of Intractable Heart Disease. Am. Heart Jour., 10, 736–761, 1935.

[21] McCreery, John A.: Total Thyroidectomy for Congestive Heart Failure and Angina Pectoris. ANNALS OF SURGERY, 103, 136–142, 1936.

[22] Mixter, C. G., Blumgart, H. L., and Berlin, D. D.: Total Ablation of the Thyroid for Angina Pectoris and Congestive Heart Failure. Results of Eighteen Months' Experience. ANNALS OF SURGERY, 100, 570–577, 1934.

[23] Ochsner, A., and DeBakey, M.: The Surgical Treatment of Coronary Disease. Surgery, 2, 428–455, 1937.

[24] Parsons, W. H., and Purks, W. K.: Total Thyroidectomy for Heart Disease. ANNALS OF SURGERY, 105, 722–732, 1937.

[25] Phillips, J. R., and Milliken, G.: Total Thyroidectomy in the Treatment of Angina Pectoris. Am. Jour. Surg., 43, 125–126, 1939.

CHRONIC GASTRIC ULCER, IN CHILDHOOD, TREATED SURGICALLY

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CHRONIC GASTRIC ULCER is a comparatively rare disease in children. Proctor[1] from this clinic reported one instance of chronic gastric ulcer in a child encountered in a series of approximately 1,600 cases of chronic gastric ulcer during the years 1906 to 1924. He collected 11 other cases from the literature. Foshee,[2] in 1932, found six other reported cases and added one of his own, making a total of 19 cases. Since that time, 15 other case reports have been found in the available literature.* All of these children were 14 years of age or younger. They had had symptoms for at least two months or their ulcers showed pathologic evidence of chronicity (Case 15, Colson, Table I). These criteria are similar to those of Proctor[1] and Foshee.[2] Pathologic reports were not available in some cases as operative treatment had not been necessary in all instances. The acute ulcer of the neonatal and early period of infancy is excluded from consideration here.

At the Mayo Clinic, from 1924 to 1939, inclusive, there have been seen approximately 2,000 cases of chronic gastric ulcer, in only one of which was the subject a child. Duodenal ulcer has been observed more frequently among children than has gastric ulcer. This is in keeping with the general frequency of the two types of ulcer.[4]

The etiology of gastric ulcer in childhood remains the same unsolved and much discussed problem as that which occurs in adult life. In this article we will refrain from entering the controversy.

The diagnosis is often difficult owing, chiefly, to the rarity of gastric ulcer in this age-group and to the bizarre symptoms which it produces in children. "The most important single factor in the diagnosis is the realization that chronic peptic ulcer occurs in children."[1] Chronic digestive disturbances, indefinite abdominal discomfort, especially epigastric in situation, anorexia, night pain and vomiting should suggest the possibility of peptic ulcer. Chronic constipation of varying degrees often occurs. The back pain in the case which we are reporting was difficult to account for. This is generally associated with a perforating ulcer into the pancreas or into the gastrohepatic omentum,[5]

Submitted for publication March 21, 1940.

* Rocher,[3] in 1934, quoting Depiersis, stated that 53 cases of gastric ulcer in childhood had been reported up until that time but he made no distinction between acute and chronic ulcers and unfortunately published no references.

TABLE I

CASES OF CHRONIC GASTRIC ULCER AMONG CHILDREN RECORDED IN THE AVAILABLE LITERATURE SINCE THE REPORT OF FOSHEE,[2] 1932

Author	Reference	Age and Sex	Duration of Symptoms	Site of Lesion	Method of Diagnosis	Therapy
Robinson, V. P.	Lancet, 2, 600, September 17, 1927	12 yrs. M.	3 mos.	Anterior wall of stomach, halfway between fundus and pylorus; nearer lesser than greater curvature (ruptured).	Surg.	Surg.
Blechmann, G., Gutmann, R. A., and Nemours-Auguste	Nourrisson, 20, 34–37, 1932	10 mos. M.	2 mos.	Pylorus.	Roent.	Med.
Oldfield, M.	Brit. Med. Jour., 1, 836–837, May 7, 1932	13 yrs. M.	2 yrs.	Posterior surface close to lesser curvature, 3 in. from pylorus.	Roent.	Med.
Jankelson, I. R.	Am. Jour. Dis. Child., 44, 162–165, July, 1932	12 yrs. M.	5 to 6 yrs.	Lesser curvature.	Roent.	Med.
		12 yrs. F.	7 mos.	Prepyloric.	Roent.	Med.
Olper, Leone	Arch. ital. d. mal. d. app. diger., 2, 39–51, 1933. Abst. Zentralbl. f. d. ges. Kinderh., 28, 335, 1933–1934	11 yrs. M.	Not given	Pyloric bulb.	Roent. and surg.	Surg.
Sáinz, de les Terreros, C., and Pérez Moreno, B.	An. Hosp. de San Jose y Santa Adela., 5, 285–294, 1933–1934; and Arch. espān. de pediat., 18, 522–534, September, 1934.	5 mos. M.	4 mos.	Lesser curvature near antrum.	Roent.	Med.
Rocher, H. L.[3]	Rev. franç de pediat., 10, 218–224, 1934	8 yrs. M.	4 yrs.	Anterior superior wall of pylorus.	Roent. and surg.	Surg.
Micheli, E.	Boll. e. mem. Soc. piemontese di chir., 4, 467–480, 1934	13 yrs. F.	1 yr.	Pylorus.	Roent. and surg.	Surg.
		12 yrs. M.	4 yrs.	Pylorus.		
Toro, N.	Pediatria, 45, 904–923, October, 1937	10 yrs. F.	1½ yrs.	Pylorus.	Clin., surg. and roent.	Surg.
		11 yrs. M.	1 yr.	Pylorus.		Surg.
Bertrand, J. C., Messina, Bernardo, and de la Fare, Mauricio	Arch. argent. de pediat., 8, 990–996, 1937. Abst. Zentralbl. f. d. ges. Kinderh., 34, 348, 1937–1938	12 yrs. F.	2 yrs	Pylorus.	Roent. and surg.	Surg.
Webster, Reginald	Med. Jour. Austral., 1, 1061–1062, 1938	4 mos. M.	3 mos.	Posterior wall at pylorus.	Necropsy*	
Colson, Cade, R., and Soustelle	Lyon. méd., 162, 35–37, July 10, 1938	14 yrs. M.	Few hrs.†	Prepyloric (ruptured).	Surg.	Surg.

* Recovery occurred in all cases except that reported by Webster.
† Ulcer indurated at operation.

but in our case there was no perforation. Low abdominal pain as observed in the case reported is another bizarre symptom for which we can offer no explanation. Hematemesis, melena or both are very suggestive of peptic ulcer. The roentgenologic picture is characteristic.[6] Whereas the latter statement is generally true, Eusterman and Balfour[4] stated that a competent roentgenologist can demonstrate 96 per cent of gastric ulcers, Kennedy[7] and Armingeat[8] have reported instances in which the surgeon could not substantiate the roentgenologist's report of ulcer but in which he found appendiceal inflammation. However, in both of these cases, the stomach and duodenum were examined without being opened. Gastroscopic examination should be carried out in doubtful cases.

It is generally agreed that the treatment for gastric ulcer is medical, except in cases in which there is perforation, suspicion of malignancy or failure of a medical regimen. In these latter cases, surgical treatment is indicated. Since the medical regimen is essentially the same for children as for adults,[9, 10] it will not be discussed here.

Case Report.—A white girl, age 12, was referred to the clinic, March 21, 1939, because of abdominal pain, vomiting and melena. The mother was considered "nervous" and was moderately deaf. The family history otherwise was not remarkable. The patient had always been considered to be a "nervous child." She had had measles, mumps, pertussis and chickenpox. She had had a tonsillectomy and adenoidectomy performed, two years previously.

During the year preceding admission, the patient had had some intermittent backache and abdominal pain. The abdominal discomfort apparently had been worse during the few months preceding registration at the clinic, and the backache, during the three weeks preceding admission. During the week previous to examination, the abdominal pain had been more severe and cramp-like, and was often worse in the lower part of the abdomen. No relation of pain to eating or to bowel movements could be determined. She had been given a cathartic once without its affecting the symptoms. During the two days before admission, she took very little orally, and had vomited dark brown to black material on three occasions. Her stools were black. At no time was there gross blood in either the stools or the vomitus.

Physical Examination.—The patient was a tall, thin, undernourished girl, with comparatively dry skin and mucous membranes. She was in no distress. The oral temperature was 99.8° F. (37.7° C.) and the pulse rate was 80. Blood pressure 130/78. The contour of the abdomen was flat. There was no spasm, mass or tenderness. Rectal examination was essentially normal, as was the rest of the examination.

The urine was normal. The concentration of hemoglobin was 12.6 Gm. per 100 cc.; erythrocytes 4,410,000; leukocytes 6,700, 27 per cent lymphocytes, 17 per cent monocytes and 56 per cent neutrophilic leukocytes. The flocculation test for syphilis and the tuberculin tests, which were made with first and second strengths of purified protein derivative, gave negative results. Blood urea 34 mg. per 100 cc. Both the benzedine and the guaiac tests for occult blood in the stool were positive. Roentgenograms of the thorax and of the dorsolumbar spine were normal. Fluoroscopic and roentgenologic examination of the stomach revealed what was interpreted as an ulcer on the lesser curvature. On reexamination, it was determined that there was an ulcer, 1.5 cm. in diameter, situated just below the angle. Gastroscopic examination revealed a lesion on the lesser curvature of the stomach which appeared to be of an infiltrating type, and, hence, one which might be malignant.

Because of the chronic, hemorrhagic nature of the lesion, and the possibility that the

lesion was malignant, an exploratory operation was decided upon, and was performed March 31, 1939 (W. W.).

Operation.—The stomach and duodenum were exposed through a midline incision. There was an ulcer situated on the lesser curvature in the region of the incisura with a crater, about 1.5 cm. in diameter, surrounded by regions of inflammation and induration of about equal size. A segmental excision of a portion of the stomach including the ulcer was made with the electrocautery, going well beyond the regions of inflammation and induration. The opening in the stomach was closed with chromic catgut and silk and was protected with omentum. The pyloric sphincter was divided longitudinally down to the mucous membrane, retracting the peritoneum and pyloric muscle laterally and covering the area with a portion of the gastrocolic omentum. At the conclusion of the operation, the appendix, which showed chronic inflammation with fibrosis, was removed. The pathologic examination of the portion of stomach removed showed a subacute hemorrhagic gastric ulcer, 2x1x5 Mm. in size. The appendix showed chronic inflammatory changes with submucous fibrosis.

The patient's postoperative course was uneventful. She was given the postoperative diet and treatment that is usual for gastro-enterostomy.[11] On the eighth day after operation, the concentration of hemoglobin was 9.7 Gm. per 100 cc. Erythrocytes 3,580,000; leukocytes 6,000. Ferrous sulfate 9 gr. (0.6 Gm.) per day was administered. The patient was discharged on the twenty-first day after operation.

The patient was reexamined four months after operation. She complained only of occasional slight abdominal pain which appeared if she ate excessive amounts of food. She had gained 3.3 lbs. (1.5 Kg.) and otherwise had remained well. Six months after operation, she was feeling very well and had had very little abdominal discomfort. She had, however, lost 4 lbs. (1.8 Kg.) since her previous visit. A program for rest was outlined. One month later, she was seen again, at which time she had regained her lost weight, but her weight was still, approximately, 25 per cent below normal. She had no complaints. Continuation of the program of rest was advised.

REFERENCES

[1] Proctor, O. S.: Chronic Peptic Ulcer in Children. Surg., Gynec., and Obstet., 41, 63–69, July, 1925.

[2] Foshee, J. C.: Chronic Gastric Ulcer in Children: Report of a Case. J.A.M.A., 99, 1336–1339, October 15, 1932.

[3] Rocher, H. L.: L'ulcère de l'estomac chez l'enfant. Rev. franç. de pédiat., 10, 218–224, 1934.

[4] Eusterman, G. B., and Balfour, D. C.: The Stomach and Duodenum. Philadelphia, W. B. Saunders Company, 1935, pp. 259, 447.

[5] Hurst, A. F., and Stewart, M. J.: Gastric and Duodenal Ulcer. New York, Oxford University Press, 1929, p. 146.

[6] Jankelson, I. R.: Peptic Ulcers in Children. Am. Jour. Dis. Child., 44, 162–165, July, 1932.

[7] Kennedy, R. L. J.: Peptic Ulcer in Children. Jour. Pediat., 2, 641–650, June, 1933.

[8] Armingeat, J.: Quelques áperçus sur l'ulcère digestif de l'enfant. Semaine d. hôp. de Paris, 10, 110–117, February 28, 1934.

[9] Eusterman, G. B., and Balfour, D. C.: The Stomach and Duodenum. Philadelphia, W. B. Saunders Company, 1935, pp. 280–294, 457–462.

[10] Brown, C. F. G., and Dolkart, R. E.: An Evaluation of the Therapy of Peptic Ulcer. J.A.M.A., 113, 276–279, July 22, 1939.

[11] Eusterman, G. B., and Balfour, D. C.: The Stomach and Duodenum. Philadelphia, W. B. Saunders Company, 1935, p. 911.

HYDROCELE OF THE FEMORAL HERNIAL SAC

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An examination of the medical literature available indicates that hydrocele of the femoral canal is an uncommon condition. Only five authentic cases were found, although a few additional reports might belong in this classification.

Probably the earliest reference to the condition was that made by Sir Astley Cooper,[3] in 1844, when he wrote: "Dr. Monro, jun., mentions an instance of an hydatid tumor which was removed from the upper and inner part of the thigh, which might easily be mistaken for hernia; and he gives another example of it from Desault, who found it transparent when a candle was brought near to it, and that he could draw it from the crural arch so as to leave a space between the tumor and the abdomen, which proved that it was not formed from it." These two, however, can hardly be accepted as authentic cases of hydrocele of the femoral hernial sac.

Erdman,[5] without reporting any cases of this type, mentioned that "a small tab of inflamed omentum with serous exudate simulating hydrocele" is "frequently" present in femoral hernial sacs; and Babcock[1] wrote: "Cysts of the femoral canal are rare, irreducible and without impulse. They may be difficult to diagnose from an irreducible hernia without exploratory incision." These authors may have recognized the condition under discussion.

In 1892, the first proved case noted in the literature was reported by Marcy,[6] as follows: "Cystic dilatation of a portion of the hernial sac may form a complication. I have very recently operated upon a woman of about 40 years of age who had suffered from femoral hernia for 12 or 13 years, much of the time wearing a truss. A portion of the tumor became irreducible, and the truss could not be tolerated. The sac was thick-walled, and the lower portion was occluded and filled with serum, making a tumor the size of an egg."

DeGarmo,[4] in 1907, commented that the neck of a femoral hernial sac is narrow, becomes tough and thickened, and, if a truss has been worn, may be closed off completely. "A sac that has been closed off in this manner is quite likely to take on a condition of hydrocele, and, as it occupies the exact site of the former hernia, is very likely to be mistaken for irreducible femoral hernia." He illustrated such a case by a drawing made from a patient. The "cyst"

Submitted for publication January 30, 1940.

was in the distal end of the sac and the "hernia proper was in the upper part of the sac and easily reduced."

In 1927, Bailey[2] reported a case of "Hydrocele of a Femoral Hernial Sac:" A woman, age 58, who had a femoral hernia of 14 years' duration, developed ascites and cardiac decompensation. After several months of treatment, the ascites disappeared, but the sac remained filled with fluid. It was aspirated and the contents subsequently became infected, requiring incision and drainage. The wound healed in two weeks and "the patient left the hospital with no sign of the femoral hydrocele."

In 1934, Rives[7] reported two cases. The first was that of a colored woman, age 33, with an asymptomatic tumor in the right groin. It had gradually enlarged to the size of a "hen's egg" during the previous five years. At operation, a thin-walled cyst containing translucent fluid was found. It communicated with the peritoneal cavity through the femoral ring. His second case was that of a colored woman, age 43, who had a mass in the left groin, of three years' duration, that had also gradually enlarged to the size of a "hen's egg." Some slight pain was associated with it at first but it later became painless. At operation, a thin-walled cyst, which communicated with the peritoneal cavity through the femoral canal, was found.

Three proved cases of hydrocele of a femoral hernial sac were seen recently on the Surgical Service of the University of California Hospital.

CASE REPORTS

Case 1.—Mrs. M. E. S., age 49, entered the University of California Hospital, April 3, 1938. She had had a small, firm lump in her left groin for about ten months. It was associated with a dragging pain which was relieved by reclining. In the left femoral region was a small, firm, tender, irreducible mass, 2.0×1.5×1.0 cm. in size. A diagnosis of femoral hernia containing incarcerated omentum was made before operation.

Operation.—April 4, 1938: Under nitrous oxide anesthesia, a left inguinal incision was made. Immediately below the inguinal ligament a rounded, fatty mass, about two centimeters in diameter, was found. Further dissection showed it to be a small hydrocele covered by a thin layer of fat. It was opened and found to contain thick yellowish fluid. The sac was lined with a smooth shining membrane. The neck of the hydrocele was dissected through the femoral canal, beneath the inguinal ligament, to its attachment to the parietal peritoneum. It was not possible to demonstrate a communication between the lumen of the sac and the peritoneal cavity. The attachment was divided and transfixed, and the femoral canal obliterated with sutures. The patient's postoperative course was uneventful and she was discharged on the eleventh day after operation. The pathologist reported that the specimen of the wall of the hydrocele was a "mesothelial-lined sac."

Case 2.—Mrs. M. C. H., age 48, entered the University of California Hospital, May 17, 1938. She complained of swelling in the right groin of 15 years' duration. At first it was about 3×2 cm. in size, but had increased gradually until about a year before her entry to the hospital, when it began to enlarge rapidly. For a short time, working or walking had caused it to become tender and painful. Examination showed a superficial mass, about 10×6×2 cm. in size, in the right groin. It was soft, rounded, fluctuant, freely movable, not tender, and seemed to be loosely attached to the deeper structures. It did not vary in size with coughing or straining. The diagnosis was somewhat uncertain, but a lipoma was thought most likely and an incarcerated hernia was considered possible.

Operation.—May 17, 1938: Under local anesthesia, an incision three inches long was made directly over the mass, which presented as a bluish, lobulated cyst. The hydrocele was dissected to the neck that entered the femoral canal. It was opened and found to contain yellow fluid, similar to that seen in hydrocele in the male. The fluid was evacuated and the neck dissected to its communication with the peritoneal cavity where it was divided and ligated. The femoral canal was obliterated with sutures. The patient left the hospital on the tenth postoperative day after an uneventful convalescence.

Case 3.—Mrs. M. M. R., age 37, entered the University of California Hospital, April 17, 1939. She complained of a swelling in the right groin of nine months' duration. During the previous four months it had increased in size and had been sharply painful at times. There had been occasional nausea but no vomiting. A small, firm mass, about two centimeters in diameter, was seen on the right side of the junction of the lower and middle thirds of the inguinal ligament. It was slightly tender and gave a slight impulse on coughing. It could not be reduced.

Operation.—April 18, 1939: Under local anesthesia, an incision was made above the right inguinal ligament. Just below the inguinal ligament there was a slightly irregular cystic mass about two centimeters in diameter, which was attached by a narrow neck through the femoral canal to the peritoneum. The external oblique muscle was opened, the femoral canal was exposed from above, and the mass was reduced through the femoral ring by traction from above. The cyst was opened and found to contain a small amount of straw-colored fluid. The lining was smooth and shining and communicated with the peritoneal cavity through a long narrow neck. The sac was dissected free of areolar tissue and closed with a suture at the neck. The hernia was repaired from above Poupart's ligament in the usual manner. The patient was discharged from the hospital on the fifteenth day after operation, with the wound healed.

Discussion.—To explain the occurrence of femoral hydrocele, it seems necessary to suppose the presence of a potential or actual femoral hernial sac or an embryologic peritoneal rest. An explanation of the appearance of the fluid is not easy. As Rives said—"the fluid rather than the hernia needs explanation, and no explanation is entirely satisfactory." He seemed to feel that the fluid from the peritoneal cavity might have gravitated to the preformed pouch and have been trapped there by adhesions across its narrow neck. Such a mechanism must certainly have produced the hydrocele in Bailey's case, in which the patient was known to have had a femoral hernial sac and to have had ascites. The additional factor of trauma, such as that caused by a truss in Marcy's and DeGarmo's patients, was not present, so far as is known, in our cases or those of Rives. Erdman suggested the factor of "inflammation." The possibility that the occlusion or isolation of the sac might in some cases be congenital is suggested by our cases, particularly the first. The accumulation of fluid in such an isolated sac would appear to be similar to that which occurs in the hydroceles of the cord and scrotum in the male and of the canal of Nuck in the female.

The diagnosis of hydrocele of the femoral hernial sac is not likely to be made before operation because of the rather frequent occurrence of incarcerated omentum in femoral hernia. Recognition at operation requires no particular consideration, however, except perhaps to note that the hydrocele should be approached from below the inguinal ligament.

SUMMARY.—Eight cases of femoral hydrocele are reported, five from the

available literature and three from our clinic. Two possible cases noted by Sir Astley Cooper, and references to somewhat similar conditions in other writings are also mentioned.

The factors involved in the formation of femoral hydrocele are discussed briefly without definite conclusion, but with the feeling that, in the authors' cases at least, congenital alterations were most likely present.

REFERENCES

[1] Babcock, W. Wayne: A Textbook of Surgery, Ed. 2, p. 1138, Philadelphia and London, W. B. Saunders Co., 1935.

[2] Bailey, Hamilton: Hydrocele of a Femoral Hernia Sac. Brit. Jour. Surg., 15, 166, 1927.

[3] Cooper, Sir Astley: The Anatomy and Surgical Treatment of Abdominal Hernia, Ed. 2, p. 206, London, Lea and Blanchard, 1844.

[4] DeGarmo, W. B.: Abdominal Hernia, Its Diagnosis and Treatment, pp. 307–308, Philadelphia and London, J. B. Lippincott Co., 1907.

[5] Erdman, Seward: Hernia. Nelson's Loose Leaf Living Surgery, 4, 647, New York, Thos. Nelson & Sons, 1927.

[6] Marcy, Henry O.: The Anatomy and Surgical Treatment of Hernia, p. 126, New York, D. Appleton and Co., 1892.

[7] Rives, James D.: Femoral Hydrocele. ANNALS OF SURGERY, 99, 989–992, 1934.

EPIDERMOID CARCINOMA OF THE EXTREMITIES WITH REFERENCE TO LYMPH NODE INVOLVEMENT

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THE TREATMENT of epidermoid carcinoma of the extremities inevitably involves a decision in regard to the treatment of regional lymph nodes. This decision must be based upon the presence or probability of development of metastatic involvement. It is the purpose of the present study to determine what characteristics of the primary lesion are associated with the probability of metastases. The accuracy of clinical appraisal of node involvement, and the efficacy of the methods of treatment of metastases when they are present, have also been investigated.

This analysis is based upon the cases of epidermoid carcinoma observed at the Massachusetts General Hospital during the years 1922–1937, at the Huntington Memorial Hospital during the years 1915–1937, and at the Pondville Hospital during the years 1927–1937. The study is not primarily an end-result study. Untraced cases have been omitted as inconclusive. In general, cures have been followed for at least three years after the last treatment was given.

Etiology.—The location, age, and sex incidence, and delay from onset to treatment are shown in Table I.

TABLE I

AGE AND SEX INCIDENCE

Location	Males	Females	Youngest	Oldest	Median Age	Average Delay to Treatment	No of Cases
Finger and hand	206	78	29	95	67	1.7 years	284
Arm	21	20	31	92	65	1.7 years	41
Foot	23	9	13	79	55	1 8 years	32
Leg	35	38	21	80	57	2 8 years	73
Totals	285	145					430

It should be noted that males predominate over females in carcinoma of the finger, hand, and foot. There is no significant difference in incidence between males and females in carcinomata of the arms and legs. The average delay to treatment is a year longer in carcinoma of the leg than in the other groups. It is noteworthy that the median age incidence is ten years younger in carcinoma of the lower extremity than in carcinomata of the upper extremity.

Submitted for publication February 2, 1940.

A high percentage of the patients (45 per cent) gave a history of preexisting lesions (Table II). Senile keratoses preceded the development of cancer in 63 instances. Arsenical keratoses were present in 14 cases. Injuries or scars preceded the development of cancer in 36 cases. In addition to cancerous degeneration of traumatic scars, there were 23 cases with cancer developing in the scar of the burn. Radiation dermatitis was present as a precancerous lesion in ten cases, and tar dermatitis was present in four cases. Chronic osteomyelitis sinuses were recorded in 11 cases, and varicose ulcers in 11 cases. In two cases, postphlebitic ulcers underwent cancerous degeneration. A few patients definitely traced their cancers to preexisting skin conditions such as eczema, psoriasis, nevus, lupus, or gumma. Callus or clavus preceded cancer in three cases, and decubitus ulcer in two cases.

TABLE II

NATURE OF PRECANCEROUS LESIONS

Precancerous Lesion	Hand and Finger	Arm	Foot	Leg	Total
Keratosis	59	2	2	0	63
Arsenical keratosis	10	0	1	3	14
Injury and scar	23	2	5	6	36
Burn scar	5	7	2	9	23
Radiation dermatitis	8	0	0	2	10
Tar dermatitis	3	1	0	0	4
Osteomyelitis sinus	0	1	1	9	11
Varicose or postphlebitic ulcer	0	0	1	12	13
All others	8	2	5	4	19
Totals	116	15	17	45	193

Treatment.—The treatment of the local lesion was chiefly surgical. Radiation was successfully employed in many of the smaller lesions, often without pathologic confirmation of the diagnosis. Undoubtedly, many of the failures were due to inadequate treatment, and most of these patients were subsequently cured by surgery.

Carcinoma of an extremity should be locally curable in all cases, provided the treatment employed is sufficiently radical. Failure of local cure is primarily due to failure to appreciate the gravity of the process and the extent of the disease. Failure of local cure may also be attributable to the presence of remote, incurable matastases which makes the employment of radical measures futile, to refusal of the patient to submit to radical surgery, or to precarious general condition of the patient which may contraindicate appropriate local treatment. Table III presents the cases of known failure of cure of the local lesion.

TABLE III

FAILURE OF LOCAL CURE

Location	No. of Cases	Known Failure of Local Cure
Finger	30	3
Hand	205	18
Arm	27	4
Foot	24	3
Leg	46	4
Totals	332	32

Carcinoma of the Finger.—There were 33 cases of carcinoma of the finger, 3 (9 per cent) of whom presented or developed axillary node metastases. All 3 presented large lesions, in 2 cases of long duration and of low grade. One case was of short duration and grading was not carried out.

Carcinoma of the Hand.—Of the 205 hand carcinomata in which information is available, 30 (15 per cent) had or developed metastases. Eighteen of these patients had the lesion graded, of which 9 were of low grade, and 9 were of higher grade. Twenty-seven of 28 lesions were large, only 1 was small; 22 were of long duration, and 6 were of short duration. It is evident that the likelihood of node involvement increases with higher grades of malignancy, and with larger lesions and those of long duration. Only 2 patients without palpable lymph nodes on admission subsequently developed regional metastases. Both of these lesions were of high grade; 1 was small, and 1 was large. In one of these cases there was failure to control the local process as well. Neither patient was submitted to regional dissection, and both died.

Carcinoma of the Arm.—There were 27 cases of carcinoma of the arm in which information is available, of which 7 (26 per cent) presented regional metastases. All were large lesions of long duration, and the 4 which were graded were all of high grade malignancy.

Carcinoma of the Foot.—There were 24 cases of carcinoma of the foot in which information is available. Ten of the patients (41 per cent) with carcinoma of the foot presented regional lymph node involvement; and in all these cases the nodes were clinically enlarged on admission. Of the lesions with positive nodes, 7 were graded, and all proved to be of high grade of malignancy. Five were of short duration, and 5 were of long duration; 7 were large, and 3 were small. It is evident the size and duration here do not play such a conspicuous part in determining the likelihood of metastasis; while higher grades of malignancy seem to be of considerable importance.

Carcinoma of the Leg.—There were 46 cases of carcinoma of the leg in which information is available. Sixteen patients presented involvement of the regional nodes (36 per cent), and in all these cases the nodes were involved on admission to the hospital. Of the lesions associated with involved nodes, 12 cases were graded, of which 4 were low grade, and 8 were high grade; 12 were of long duration, and 4 were of short duration. Fourteen lesions were large, and 2 were small. Grade, size, and duration are all important in determining the probability of metastasis.

In summary of these groups of cases, it is evident that grade of malignancy, size, and duration of the lesion all have significant bearing on the likelihood of development of regional node involvement.

Table IV presents the incidence of regional node metastases from primary carcinoma in the various areas.

Clinical Appraisal of Lymph Node Involvement.—In the following analysis, nodes were considered to be free from metastasis when they showed no sign of involvement histologically, or when cure was effected by treatment of

the local lesion alone. Likewise, nodes were considered to be involved when they showed histologic evidence of metastasis, or when in advanced stages of the disease the clinical diagnosis of metastasis was obvious.

TABLE IV

INCIDENCE OF LYMPH NODE INVOLVEMENT

Location	No. of Cases	Node Metastasis	Percentage of Node Metastasis
Finger	33	3	9
Hand	205	30	15
Arm	27	7	26
Foot	24	10	41
Leg	46	16	36
Totals	335	66	

Among 154 patients with carcinoma of the upper extremity associated with nodes less than 1 cm. in diameter, actual metastasis was present or developed in 16 cases (11 per cent), and was absent in 138 cases. When nodes 1 to 2 cm. in size were present at the time of dissection, 5 cases (20 per cent) presented actual metastatic involvement, while 20 cases proved to be free from axillary disease. When nodes over 2 cm. in size were present they proved to be involved in 25 cases (86 per cent) and uninvolved in only 4 cases.

In the cases of carcinoma of the lower extremity, of 35 cases without appreciably enlarged nodes, metastasis was present in 5 (14 per cent). Fifteen patients presented nodes 1 to 2 cm. in size, and among these, metastases were present in 9 cases (60 per cent). Eighteen patients presented nodes over 2 cm. in diameter, and 17 of these harbored metastases. One patient who at the time of groin dissection proved to be free from metastasis, subsequently developed fatal recurrence in the groin area. The incidence of metastatic involvement in relation to the size of lymph nodes is shown in Table V.

TABLE V

INCIDENCE OF METASTATIC INVOLVEMENT IN RELATION TO SIZE OF LYMPH NODES

Location	Size of Nodes	No. of Cases	No. of Cases with Metastases	Percentage with Metastases
Axillary	0–1 cm.	154	16	11
Axillary	1–2 cm.	25	5	20
Axillary	Over 2 cm.	29	25	86
Inguinal	0–1 cm.	35	5	14
Inguinal	1–2 cm.	15	9	60
Inguinal	Over 2 cm.	18	17	94
Epitrochlear	0–1 cm.	15	3	20
Epitrochlear	1–2 cm.	11	8	72
Epitrochlear	Over 2 cm.	7	7	100
Totals		309	95	

There is a definite possibility of metastatic involvement even when nodes are impalpable or small, and when nodes are larger than 1 cm. the probability of metastasis is greatly increased. The relatively low incidence of involvement in axillary nodes 1 to 2 cm. in size (20 per cent) is probably due to the inflammatory enlargement of nodes in many instances of hand carcinoma with infected ulcerations. It is evident that clinical appraisal of lymph node size

and involvement is more accurate in examination of the groin than it is in examination of the axilla.

Only one patient in the entire series developed metastasis to the popliteal lymph node area, and in this patient the involvement was clinically obvious, and recurrent disease proved to be fatal notwithstanding dissection.

Epitrochlear lymph nodes were described in 33 cases. The nodes were less than 1 cm. in size in 15 cases, of which only 3 (20 per cent) showed metastases. In 11 cases the nodes were 1 to 2 cm. in size, and of these, 8 (72 per cent) harbored metastases. Seven cases presented nodes over 2 cm. in size, and all proved to be cancerous. The statistics indicate that dissection should be carried out in any case in which the nodes in this area are palpable.

Efficacy of Lymph Node Dissection.—There was no fixed policy in regard to management of the regional lymph nodes. In most cases, small lesions without palpable regional lymph nodes received no primary treatment directed to the nodes. These cases were kept under observation, and later dissections were carried out if nodes appeared. Patients with more extensive local lesions were often subjected to primary dissection of the regional nodes, even in the absence of palpable metastatic involvement, as a prophylactic procedure. The dissections were usually performed at the same time as treatment to the primary lesion, and in other cases deferred for a few weeks. The dissections varied from simple excision of involved nodes to a block dissection of the entire lymph node drainage area.

In attempting to appraise the efficacy of lymph node dissection, it is arbitrarily assumed that patients who were free from any evidence of disease for two years or longer after treatment represented a "cure." This is desirable because otherwise it would be necessary to exclude as inconclusive a considerable number of cases in which the patients were untraced after two years and the results in which are of value in the inquiry into the adequacy of operation. The statistics, obviously, have no standing as an end-result study, and should not be so considered.

Axillary dissection was performed in 44 cases and the nodes proved to be involved in 21 instances. Nine cases were "cured," 11 died of recurrence, and 1 case was untraced and inconclusive. Thus, "cures" were obtained in 45 per cent of the 20 traced patients in whom axillary metastases were removed by lymph node dissection. There was one operative fatality among the cases submitted to axillary dissection.

The epitrochlear area was dissected in 16 cases, and the nodes were involved in 11 of these. One case was untraced and inconclusive, 7 were cured, and 3 patients ultimately succumbed probably because of failure to control the coincident axillary involvement.

Supraclavicular dissection was carried out in one case in which the nodes were obviously involved, but the patient succumbed to recurrence.

Groin dissection was performed in 28 instances, and nodes proved to be involved in metastases in 14 of these. Two patients were untraced, and hence inconclusive; 2 were cured, and 10 developed recurrence notwithstanding

dissection. Eight of these 10 represented delayed cases, in which dissection was not part of the original plan of treatment, but in which subsequent development of obvious clinical metastasis necessitated the operation. One patient who was submitted to a second groin dissection for recurrence was "cured." There was one operative fatality in the group submitted to groin dissection, who died as a result of acute cholecystitis which developed during the convalescence.

The popliteal area was dissected in two cases. In one of these the nodes were involved, and the patient succumbed to recurrence. The case in which the nodes were not involved could not be traced.

Roentgenotherapy was employed in a considerable number of patients with node involvement, in which the disease was inoperable or in which the patient's condition did not warrant dissection. In no instance was a cure obtained by this means.

Time of Appearance of Node Involvement.—Knowledge is available in regard to appearance time of axillary nodes secondary to hand and arm malignancies in 45 cases, and of inguinal nodes secondary to foot and leg cases in 23 cases.

TABLE VI

TIME OF APPEARANCE OF NODE INVOLVEMENT IN RELATION TO DURATION OF PRIMARY DISEASE

Metastasis Present After Onset of Primary Lesion	Per Cent of All Known Axillary Nodes	Per Cent of All Known Inguinal Nodes
Less than 6 mos.	22	40
Less than 1 yr.	36	52
Less than 18 mos.	48	56
Less than 2 yrs.	73	60
Less than 3 yrs.	75	65
Over 3 yrs.	25	35

In general, 75 per cent of axillary metastatic involvements, and 65 per cent of inguinal metastatic involvements, are present within three years after the onset of the primary tumor. Bearing in mind that the mean delay from onset to treatment of the primary lesion is 1.7 years in the upper extremity cases, and 2.8 years in the lower extremity cases, it is evident that a 2 to 3 year follow-up period after treatment should permit the detection of practically all regional metastases.

Metastases in Relation to Etiology.—None of the 11 patients with carcinoma originating in consequence of chronic osteomyelitis developed regional node involvement. There were 7 instances (30 per cent) of metastasis from carcinomata originating in burn scars, 4 (30 per cent) from carcinomata in varicose ulcers, 3 (21 per cent) from arsenical cancer, and 1 each in carcinomata originating in lesions of syphilis and lupus. Thus, with the exception of osteomyelitis, these precancerous lesions seem to give rise to cancers with a considerable likelihood of metastasis formation.

Duration of Disease in Fatal Cases.—Further knowledge in regard to needful follow-up period may be derived from the length of life after treatment, in cases who succumbed to recurrence. There were 41 cases who died

of recurrence of carcinoma of the upper extremity, in whom the time of death could be accurately determined. Twenty-three of these were dead within one year of treatment, and 37 within two years. Only 10 per cent survived longer than two years. Similar data are available in 27 cases of carcinoma of the lower extremity. Twenty-three of these patients had died within two years, and 26 within three years of the date of treatment. These statistics again emphasize that a relatively short follow-up period after treatment is probably sufficient for most cases, and that late manifestation of recurrence is exceptional.

Discussion.—Carcinomata of the extremities are, in the main, slowly growing, and of a low grade of malignancy. Failure to cure the local lesion is frequent and should be avoidable. The likelihood of metastasis is increased with longer duration, larger size, and higher grades of malignancy.

The size of regional nodes is not dependable as a guide to the presence or absence of metastasis. Small and inconspicuous nodes may harbor metastases in a definite number of cases. These metastases occur chiefly in association with large lesions of high grade of malignancy and of long duration. With larger nodes the likelihood of metastasis is greatly increased. Metastasis is very common in lesions involving the arms, legs, and feet. Metastasis is also common when a recognizable precancerous condition has been present for a considerable time. The conspicuous exception to this statement is carcinoma secondary to osteomyelitis, in which no metastases were observed.

Axillary and epitrochlear dissections are followed by cure in a considerable number of instances in which metastases occur. On the other hand, cures following dissection of inguinal metastases are relatively infrequent. It is probable that earlier and more thorough dissections would improve the results to be secured in these cases. There is insufficient data to permit a comparison of the efficacy of primary with delayed dissection. It is probable that if regional lymph node dissection is carried out as soon as node enlargement becomes evident the results will be nearly as good as when prophylactic dissections are employed. The policy of watchful waiting involves frequent and conscientious follow-up observation, and depends upon the complete and intelligent cooperation of the patient.

Lesions which are likely to develop metastases usually present them within a few years of the onset of the primary lesion. Late appearance of regional metastasis, especially after the eradication of the primary disease, is infrequent. Untreated and recurrent cases go on in a matter of a few years to a fatal termination, and late recurrence is relatively rare. For these reasons, it is perhaps not so necessary to subject these patients to the protracted follow-up observation period which is so important in some other types of malignant disease.

CONCLUSIONS

On the basis of the findings, treatment of the primary lesion must be prompt and thorough. Treatment of the lymph node area should be deferred

until after extirpation of the primary disease. When enlarged nodes persist after removal of the primary growth, regional dissection must be carried out as part of the initial treatment.

Differences of opinion will exist as to whether prophylactic dissection is justifiable in the absence of palpable lymph nodes. The high incidence of metastasis in carcinomata of the arm, leg, and foot (except for those cases associated with osteomyelitis) justifies the performance of prophylactic dissection in these cases, when the lesion is of any considerable extent. Likewise the high incidence of metastases in cases originating from a preexisting precancerous lesion (again except for osteomyelitis) strongly argues for prophylactic lymph node dissection. Primary dissection may be omitted in the absence of palpable nodes, in carcinomata of the fingers and hand, provided that the patient can be kept under close and strict surveillance for at least three years. During the first six months after operation, the patient should be observed at least once a month. During the next two years probably once in two months is often enough. Exceptionally, in poor risk patients, primary dissection may be omitted in some of the other groups of patients without palpable nodes, when there is opportunity for close surveillance.

Careful observation should be directed to the epitrochlear region as well as to the axilla, in cases with carcinoma of the upper extremity. Dissection of this area should be carried out if the nodes are palpable, and axillary dissection is indicated in all patients with epitrochlear node metastases.

REFERENCES

[1] Taylor, G. W., and Nathanson, I. T.: Evaluation of Neck Dissection in Carcinoma of the Lip. Surg., Gynec., and Obstet., 69, No. 4, 484–492, October, 1939.

[2] Warren, S., and Hoerr, S. O.: A Study of Pathologically Verified Epidermoid Carcinoma of the Skin. Surg., Gynec., and Obstet., 69, No. 6, 726–737, December, 1939.

HYPOPROTHROMBINEMIA: EFFECT OF PERORAL AND PARENTERAL ADMINISTRATION OF A SYNTHETIC VITAMIN K SUBSTITUTE (2-METHYL-1, 4-NAPHTHOQUINONE)*

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WHEN THE VALUE of alfalfa concentrates rich in vitamin K, used in the hemorrhagic disease of obstructive jaundice, was discovered, attempts were made to purify the extracts and isolate the active principle. As purer concentrates were prepared, insight into the chemical nature of the vitamin was rapidly obtained. In 1938, Almquist[1] pointed out that the then generally known properties of the vitamin indicated it to be a complex unsaturated hydrocarbon of low melting point. A little later, McKee and his associates[2] suggested that the vitamin had a quinoid structure. The first synthetic compound, shown to have vitamin K activity by Almquist and Klose,[3] was phthiocol (2-methyl, 3-hydroxy-1, 4-naphthoquinone), isolated from the tubercle bacillus, in 1933, by Anderson and Newman.[4] The first synthesis of vitamin K_1 was by Almquist and Klose,[5] who tentatively identified it as 2-methyl-3-phytyl-1, 4-naphthoquinone. Just previous to this, Ansbacher and Fernholz[6] reported upon the remarkably high vitamin K activity of 2-methyl-1, 4-naphthoquinone. This quinone has since been found to be so much more active (about four times as much) than vitamin K[7, 8] that it has led workers[9] to suggest that one unit of vitamin K activity be defined as the antihemorrhagic activity of one microgram of 2-methyl-1, 4-naphthoquinone. In spite of its high potency, the low solubility of this quinone, added to its irritating qualities when given parenterally, have restricted its usefulness somewhat. Attempts to find a product less irritating and more soluble yet retaining the high vitamin K activity of that quinone have, so far, proved fruitless. Toxicologic studies in animals have shown that the quinone possesses some toxic properties, though to obtain such effects amounts considerably higher than the therapeutic dose are required.[10] The crystalline quinone forms a yellow powder, well soluble in oil but soluble only one part in 10,000 of water at room temperature, and in a proportion of two and one-half parts to 10,000, if the solution is warmed to body temperature

* Presented before the Philadelphia Academy of Surgery, December 11, 1939. Submitted for publication March 29, 1940.

Methods.—The quinone* was given to patients perorally in the form of corn oil capsules (each containing 1 mg. of the drug), or intravenously in normal saline solution; in the latter case 10 mg. of the drug was dissolved in 50 cc. of hot physiologic salt solution just before the injection. For convenience, 10 mg. quantities were weighed out, placed in dark amber glass ampules, sterilized (120° C. for 30 mins. at 15 lbs. pressure), sealed and kept in a dark place. When it was desired to use the material the contents of one ampule was dissolved in 1 cc. of absolute ethyl alcohol and slowly poured into 50 cc. of warm sterile physiologic salt solution in a flask wrapped in black paper. The instability of the drug in watery solution makes these precautions desirable.

Plasma prothrombin was measured by the method of Quick.[11] Each reading represents the average of four simultaneous determinations on the same specimen. The average of the pooled times of three normal plasmas was used as representing 100 per cent prothrombin. Whenever possible the same three normal young adults were used for this purpose, blood (2.25 cc.) being collected from them regularly three times a week for as long a period as two months, continuously. These long periods of observation disclosed the fact that some individuals have a prothrombin concentration at a constantly higher (or lower) level than other normal individuals, a point to be discussed in greater detail elsewhere.

TABLE I

INTRAVENOUS ADMINISTRATION OF 2-METHYL-1, 4-NAPHTHOQUINONE

No.	Patient	Diagnosis	Prothrombin %		Amt. Given	Time Interval (Days=d. Hrs.=h.)	Bile Salts	Bleeding Site	Remarks
			Before	After	Mg.		Gm.		
1	F. McG.	Cholecystectomy; bil. fistula	20	55	2	3 h.	0	Wound	Bleeding ceased
2	M. T.	Carcinomatosis, abdominal	10	80	6	5 d.	0	Urin. bladder	3 injections; bleeding stopped after 1st injection
3	M. C.	Carcinoma of the rectum	27	49	2	3 d.	0	Skin	Colostomy
4	E. G.	Cirrhosis of the liver	40	37	2	4 h.	0	0	Ser. bilirubin, 2.3 mg.
5	F. C.	Cirrhosis of the liver	45	42	2.5	2 h.	8	0	No subseq. rise. Ser. bilirubin = 3.0
6	Bar.	Carcinoma of tongue	46	44	2	2 h.	0	Ulcer of tongue	Left hospital 2 days after
7	Tib.	Lung abscess	43	45	2	2 h.	0	0	No subseq. rise
8	S. M.	Fatty liver; alcohol. cirrh.	44	48	9	9 d.	0	Gums	Ser. bilirubin = 1.2; 6 inj.
9	F. M.	Lung abscess	55	100	2	7 h.	0	0	No rise on oral administration previously

Results.—In Table I are listed the changes in the plasma prothrombin of various patients who received the quinone intravenously. In only three

* The 2-methyl-1, 4-naphthoquinone in liquid oil, in oil capsules or in powder was supplied by Dr. A. Black of the Squibb Research Institute.

of these patients was the prothrombin below 30 per cent of normal; in two of them (Nos. 1 and 2) there was a prompt and favorable response accompanied by diminution and disappearance of the signs of bleeding, and in the third (No. 3), the bleeding diminished, but it was not possible to measure the prothrombin until three days after the injection, when a significant rise was observed. A change from 20 to 55 per cent was detected as early as three hours after an injection in a patient (No. 1) bleeding from a wound, following a cholecystectomy. In another patient (No. 9), with a lung abscess occupying almost the entire right lung, the plasma prothrombin increased from 55 to 100 per cent within seven hours after an injection.

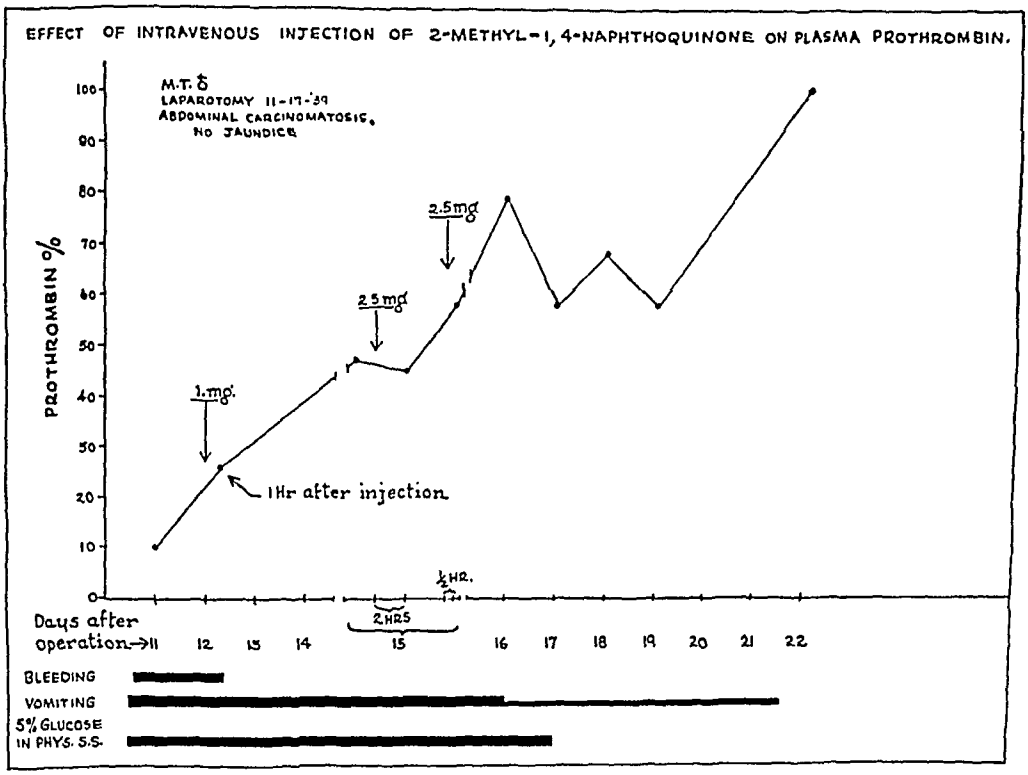


CHART 1.—Arrows indicate time of injections.

Chart 1 illustrates the increase in the plasma prothrombin after intravenous injection of 2-methyl-1, 4-naphthoquinone in a patient who had been vomiting almost continuously for 11 days following a celiotomy. Just before the administration of the synthetic compound, she had been passing large amounts of blood in the urine, as obtained by catheter. Coincident with the rise of the plasma prothrombin the bleeding stopped and did not recur. In all others listed in Table I the drug was administered intravenously, not on account of the level of the plasma prothrombin or because of manifestations of bleeding, but as a test of the power of the drug to raise the level of the prothrombin from moderately low concentrations, and as a preparation for a surgical procedure or a paracentesis. The plasma prothrombin in these patients was between 40 and 50 per cent, and in none of

them was there a significant, immediate or delayed rise after the injections, amounting in one patient (No. 8) to as many as six for a total of 9 mg. of the quinone

Chart 2 illustrates the changes in the plasma prothrombin concentration in a woman with advanced, alcoholic fatty cirrhosis of the liver. This patient during a prolonged hospital stay, not indicated on the table or in the chart, received by mouth large amounts of the various potent natural vitamin K concentrates as well as the quinone, with or without bile salts.

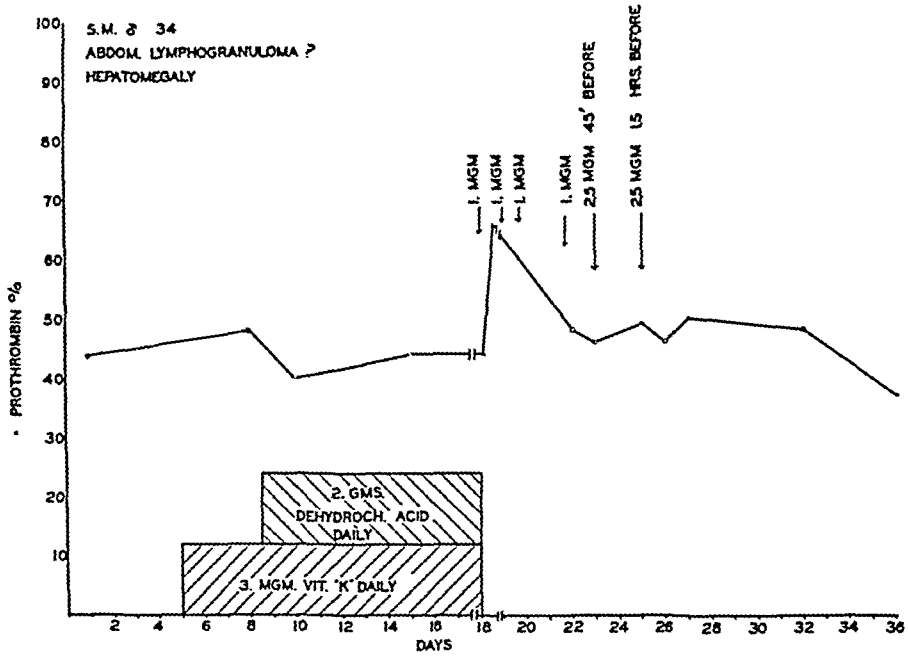


CHART 2.—Effect of peroral (blocked area) and intravenous (arrows) administration of 2-methyl-1, 4-naphthoquinone. At autopsy, it was demonstrated that the patient had alcoholic, fatty metamorphosis of the liver. The provisional clinical diagnosis of abdominal lymphogranuloma had been made during life.

"Klotogen" and "Cerophyl," and as much as 9 mg. of the quinone per day was given to the other patients who were refractory to the therapy in the usual doses. In patients with suppurative diseases of the lung, a hypoprothrombinemia is an almost constant finding, and it appears that it is only with large doses of the vitamin or its substitutes that the deficiency may be overcome.

In the group of patients with hepatocellular disease (Nos. 4, 5 and 8), intravenous administration could not, of course, be expected to correct the fundamental cause for the hypoprothrombinemia, namely interference with production of prothrombin by the liver. Vitamin K therapy, combined with plasma or whole blood transfusions, might have been more effective in raising the prothrombin level in this group, the introduced blood supplying materials other than vitamin K required for the production of prothrombin. With one exception, none of these patients exhibited any signs of bleeding even during or after extensive operations (*e.g.*, resection of the sigmoid). In this group the blood prothrombin level does not seem to constitute as sensitive an indicator of a tendency to bleed as in the hypo-

prothrombinemias due to a vitamin K deficiency. The possibility remains that the 40–50 per cent levels found in this group do not truly express the amount of plasma prothrombin in these patients; the method employed for measuring prothrombin may be influenced by qualitative changes in this substance and thus yield, sometimes, a confusing result.

There were no manifestations at any time that could be interpreted as toxic effects of the drug. A few patients complained of a burning sensation along the course of the vein while the injection was being given.

TABLE II

ORAL ADMINISTRATION OF 2-METHYL-1, 4-NAPHTHOQUINONE

No.	Patient	Diagnosis	Prothrombin % Before	Prothrombin % After	Amt. Given Mg.	Time Interval Days = d.	Bile Salts Gm.	Bleeding Site	Remarks
1	J. M.	Incomplete abortion	22	78	6	3 d.	0	Menorrhagia	Bleeding abated before D. and C.
2	R. M.	Obstructive jaundice	25	200	4	2 d.	0	Skin hematoma	Bleeding ceased
3	Tib.	Lung abscess	40	43	8	4 d.	0	0	No subseq. rise
4	S. M.	Fatty liver; alcohol. cirrh.	48	44	30	10 d.	14	Gums	
5	R. C.	Abdominal lymphogranuloma	45	47	7	7 d.	10	Skin	Provis. diagnosis
6	E. P.	Portal cirrhosis	22	36	7	7 d.	4	Skin	Ser. bilirubin = 23
7	E. P.	Portal cirrhosis	36	50	21	7 d.	0	Skin	Ser. bilirubin = 26
8	C. B.	Carc. rectum; liver metast.	25	43	54	17 d.	0	0	No unusual bleeding at oper.
9	C. H.	Carc. liver; metastatic	24	100	4	4 d.	0	0	Ser. bilirubin = 22
10	G. C.	Coronary art. dis.	57	90	4	4 d.	0	Bowel	Bleeding stopped
11	A. R.	Prostatectomy; hyper. prostate	50	93	27	9 d.	0	Wound	Bleeding stopped
12	E. M.	Gastric resection	10	90	2	2 d.	0	Bowel	Bleeding stopped
13	L. W.	Cholecystotomy; cholelithiasis	22	100	2	2 d.	0	Wound	Bleeding stopped
14	F. C.	Portal cirrhosis	37	48	21	7 d.	14	0	
15	N. C.	Cholecystectomy; cholelithiasis	50	70	10	10 d.	0	0	No jaundice
16	H. H.	Gastrocolic fistula	40	120	25	5 d.	0	0	
17	F. N.	Carc. rectum; metast. liver	60	55	15	3 d.	0	0	
18	E. G.	Cirrhosis of liver	42	43	28	4 d.	0	0	Ser. bilirubin, 2.3 mg.
19	F. M.	Lung abscess	45	55	16	2 d.	0	0	
20	Baby B.	Hemorrh. disease; newborn	<1	100	0.3	1 d.	0	Internal ear; puncture wounds	Bleeding stopped 2 hrs. after giving 0.1 mg.

In Table II are listed the changes produced by the oral administration of the quinone in liquid corn oil or in corn oil capsules. The impression was obtained from the diminution in the bleeding, that in those patients who could retain the material by mouth, almost as prompt a rise in the plasma prothrombin took place as after intravenous administration. The

group that proved refractory to therapy was again that in which the prothrombin was generally between 30 and 50 per cent of normal to begin with, and in whom hemorrhagic manifestations were seldom found.

Patient E. M. (Chart 3), who had undergone a subtotal gastrectomy for gastric and duodenal ulcers, and was vomiting most of his liquid feedings, had to be given several blood transfusions to replace the blood lost in the bowel. The prothrombin eight days after the operation was 10 per cent. Administration of 1 mg. of the quinone by mouth raised the prothrombin

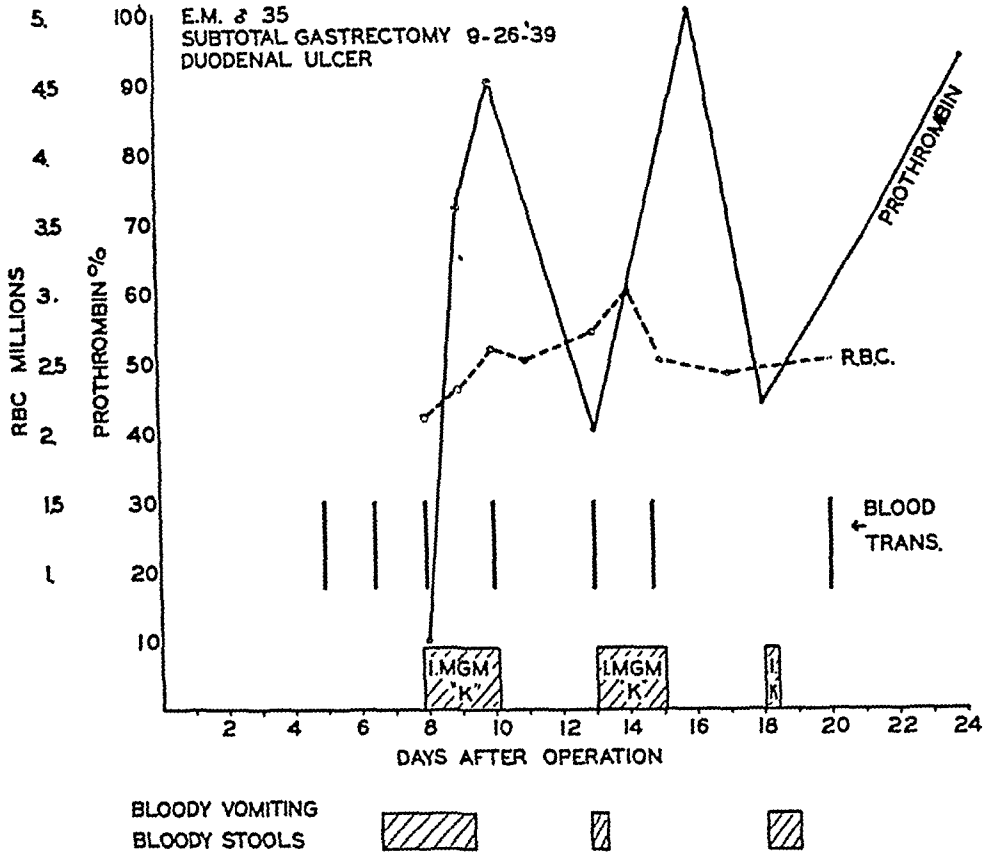


CHART 3.—Effect of blood transfusions (heavy vertical lines) and peroral administration (blocked areas) of 2-methyl-1, 4-naphthoquinone. The drug was purposely withdrawn at intervals to note the effect on bleeding and plasma prothrombin. Dose in milligrams per day indicated in the area.

to 72 per cent of normal in 24 hours. It was felt that in this, and other patients reacting in an analogous manner, ingestion of the drug followed by a blood transfusion led to more rapid and favorable results than by the drug alone. Blood transfusions alone are known to produce only a small and transient rise in prothrombin.[12]

Patient L. W. (Chart 4), who underwent a cholecystotomy, is another example of the same type of reaction. Both of these patients must have been entirely depleted of the vitamin by their illness and postoperative vomiting, for, though a prompt rise followed ingestion of as little as 1 mg. of the quinone, the high prothrombin level was not maintained when the drug was withdrawn. Table II serves also to illustrate the variety and number

of clinical conditions in which a hypoprothrombinemia is responsible for what may constitute the most important complication of the disease—excessive bleeding. Patient J. M. (No. 1), for example, developed a hypoprothrombinemia following an infected, incomplete abortion; the bleeding stopped promptly after therapy with the synthetic quinone, to recur when its administration was discontinued temporarily. How a vitamin K

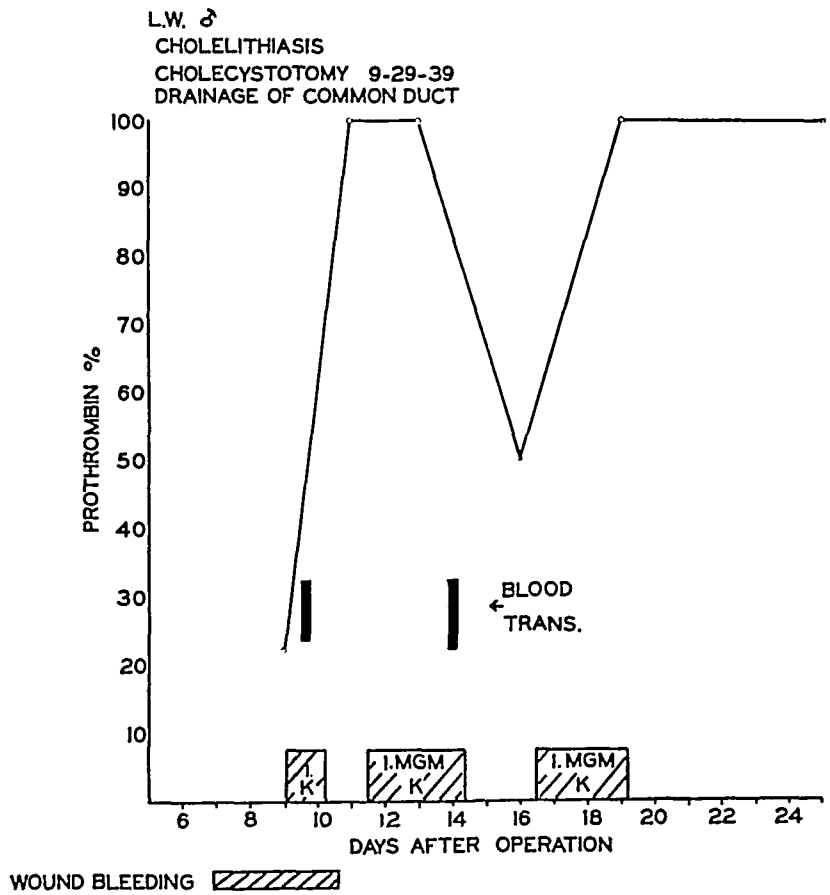


CHART 4.—Effect of blood transfusions and peroral administration of 2-methyl-1, 4-naphthoquinone on plasma prothrombin.

deficiency developed in this and other similar cases is not, at present, apparent.

SUMMARY

(1) In 23 patients with various grades of hypoprothrombinemia, 29 trials of the effect of oral or intravenous administration of 2-methyl-1, 4-naphthoquinone were carried out

(2) A dose as small as 1 mg. per day, in an adult, may cause a prompt, substantial rise in the plasma prothrombin from low levels, and check all hemorrhagic manifestations. Higher doses appear necessary to produce an effect when these small doses fail.

(3) After intravenous administration, a significant rise may be detected as early as three hours after an injection. No signs of a toxic effect were observed.

(4) A group of moderately hypoprothrombinemic patients, chiefly with hepatocellular disease, appear refractory to therapy with the quinone as well as with natural vitamin K.

(5) Blood transfusion combined with therapy with the quinone may produce quicker results than the quinone alone.

REFERENCES

[1] Klose, A. A., Almquist, H. J., and Mecchi, E.: Jour. Biol. Chem., 125, 681, 1938.
[2] McKee, R. W., Binkley, R. W., MacCorquodale, D. W., Thayer, S. A., and Doisy, E. A.: Jour. Am. Chem. Soc., 61, 1295, 1939.
[3] Almquist, H. J., and Klose, A. A.: Jour. Am. Chem. Soc., 61, 1611, 1939.
[4] Anderson, R. J., and Newman, M. S.: Jour. Biol. Chem., 101, 773, 1933.
[5] Almquist, H. J., and Klose, A. A.: Jour. Am. Chem. Soc., 61, 2557, 1939.
[6] Ansbacher, S., and Fernholz, E.: Jour. Am. Chem. Soc., 61, 1924, 1939.
[7] Almquist, H. J., and Klose, A. A.: Jour. Biol. Chem., 130, 787, 1939.
[8] Fernholtz, E., and Ansbacher, S.: Science, 90, 215, 1939.
[9] Thayer, S. A., Binkley, S. B., MacCorquodale, D. W., Doisy, E. A., Emmett, A. D., Brown, R. A., and Bird, O. D.: Jour. Am. Chem. Soc., 61, 2563, 1939.
[10] Black, A.: Personal communication.
[11] Quick, A. J.: Am. Jour. Physiol., 118, 260, 1937.
[12] Stewart, J. D.: ANNALS OF SURGERY, 109, 588, 1939.

THE LOCAL USE OF SULFANILAMIDE, SULFAPYRIDINE AND SULFAMETHYLTHIAZOL*

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OUR INTEREST in the local implantation of sulfanilamide powder was aroused by the results obtained in the treatment of compound fractures at Doctor Zierold's clinic, in Minneapolis. This work, published by Jensen, Johnsrud and Nelson,[1] showed that the local implantation of sulfanilamide powder in the wound before suturing the débrided compound fracture reduced the incidence of infection at that hospital from 27 to 5 per cent. We not only adopted this method of treating compound fractures, but, since we had been disappointed in the effect on local lesions after the oral administration of sulfanilamide, we have been using the drug locally in infections of soft tissues and of bone, and have used it prophylactically in certain clean operations where there was considerable tissue damage or where foreign material was left in the wound. We have also used it routinely in wounds after operations on tissues which had previously been infected and in operations near infected tissue, such as amputations for infection and plastic operations for chronic osteomyelitis. The clinical results have been satisfactory.

We, naturally, wanted to know whether or not the drug damaged the tissues or interfered with wound healing. We also have been troubled concerning the sterility of the drug, because, when we put foreign material in a clean operative wound, we want to be sure that the material is sterile, or at least that it will be bactericidal. It is well-known that the results obtained in animals with sulfanilamide cannot be duplicated in the test tube. This is due to two factors: (1) Sulfanilamide in the dilute concentrations which are obtained in the blood is merely bacteriostatic for susceptible organisms and the bacteria must then be destroyed by the clearing mechanism of the infected animal. In the test tube there is no clearing mechanism and eventually the bacteria begin to grow; and (2) the action of sulfanilamide is inhibited by small amounts of peptone and peptone-like substances in culture media and most culture media contain peptone (Lockwood[2]). If these substances are omitted from the media and the number of bacteria is small, then the results of an *in vitro* experiment approach those obtained *in vivo*, but thick suspensions of bacteria give off substances which inhibit the action of sulfanilamide and of sulfapyridine (Fleming[3]).

It is further to be noted that the efficiency of sulfanilamide varies directly with the concentration of the drug which comes in contact with the bacteria and inversely with the number of bacteria present. When we put sulfanilamide powder in a wound, the serum which collects in the wound will become sat-

* Read before the American Surgical Association, May 1, 2, 3, 1940, at St. Louis, Mo.

urated with the drug. As this is soluble up to about 1 per cent at body temperature, the concentration obtained in the wound is almost 100 times that which is obtained in the blood after therapeutic doses. This concentration of the drug is constant until the drug is absorbed and is not limited to the wound, but extends into the surrounding tissues, as can readily be demonstrated by placing "prontosil soluble" in a wound and examining the wound 12 hours later. The red dye diffuses into and stains the tissues for a considerable distance around the wound.

When the concentration of sulfanilamide is increased to near the saturation point, its range of activity is greatly broadened and we are no longer dealing with a drug which is merely bacteriostatic for certain *Beta*-hemolytic streptococci and a few other susceptible bacteria, but we have a drug which affects a wide variety of organisms. Among these are staphylococci and C. welchii (Spink,[4] and Sadusk and Manahan[5]). Also, the drug is no longer merely bacteriostatic, but is actually bactericidal if the organisms are not too numerous and if the culture medium is favorable to the action of the drug.

In our wounds, we have a test tube experiment with a saturated solution of the drug. This is modified by certain factors. The first of these is that we have a culture medium which is unfavorable to the sulfanilamide, because tissues break down into peptone-like substances. King and Henschel[6] have shown that the products of tissue disintegration inhibit the action of the drug. The other two factors are favorable, because sulfanilamide neutralizes the toxins of staphylococci and C. welchii (Carpenter and Barbour[7]) and thus limits the amount of tissue breakdown.

In addition to the above, we have in the wound the normal clearing mechanism of the animal and apparently phagocytosis occurs and tends to get rid of the few organisms which are left and which are prevented from growing. It is not known just what effect a saturated solution of sulfanilamide has on leukocytes, but apparently leukocytes and connective tissues are very resistant to the drug, and King[8] has shown that a concentration of 100 mg. per cent accelerates the migration rate of leukocytes.

In a previous publication (Key and Burford[9]) it has been shown that sulfanilamide powder in experimental fractures in animals does not measurably inhibit the union of the bone or the healing of the wound. On the other hand, Bricker and Graham[10] have shown that in animals in which a therapeutic concentration of sulfanilamide was maintained in the blood, experimental wounds in the stomach did not heal quite as firmly in a given length of time as did those in normal control animals.

Clinically, we have observed that some of the wounds in which we have placed sulfanilamide crystals have not healed normally; that is, it is not unusual for a considerable amount of dark red, bloody fluid to collect in these wounds. Usually this is absorbed without separation of the skin edges and the wounds heal *per primam*. Occasionally, it drains out through a small opening in the skin and then the wound heals, although somewhat more slowly than usual. We believe that this is because sulfanilamide interferes with the

formation of the clot. When the dry powder is mixed with normal blood it delays the clotting time and interferes with the formation of the clot. It is possible that this slight interference with the healing of the wound can be lessened by not putting as much powder in the wound as we have done in the past.

Since sulfanilamide is not entirely satisfactory, and since its general effect is limited to certain susceptible bacteria which are relatively few in number, chemists have produced new compounds related to this drug and have tried out the effect of these compounds on various types of organisms, both *in vitro* and *in vivo*. Among these, sulfapyridine has proved its value in the treatment of infections due to pneumococci, and there is some evidence that it is more active against staphylococci than is sulfanilamide.

Recently, a new compound, sulfamethylthiazol, has been produced and its use is now in the experimental stage. Barlow and Homburger[11] have shown that sulfamethylthiazol prolongs the life of mice infected experimentally with a virulent strain of *Staphylococcus aureus* and prevents the development and permits the healing of abscesses in kidneys and other organs in a significant number of animals, and Rake and McKee[12] have shown that sulfamethylthiazol *in vitro* is more active against *Staphylococcus aureus* than is sulfapyridine and that it protected mice from infection with staphylococci in a high percentage of the animals infected. McKee, Rake, Greep and van Dyke[13] have shown that when these compounds are administered in 1 per cent of the diet the effect of sulfathiazol is equal to that of sulfapyridine in protecting mice from infection with pneumococci. Lawrence[14] has shown that thiazol compounds in concentrations as low as 5 mg. per cent are superior to sulfanilamide and sulfapyridine in their inhibitory actions on pneumococci and *Beta*-hemolytic streptococci. The methyl and phenyl derivatives were found to be bacteriostatic for *Staphylococcus aureus* while sulfanilamide and sulfapyridine exhibited only a moderate degree of inhibition upon this organism. He used concentrations as high as 200 mg. per cent of each drug. Barlow and Homburger[15] concluded that the chemotherapeutic effects of three thiazol derivatives of sulfanilamide under conditions of experimental streptococcal or pneumococcal infections are definitely superior to those of the parent substance and compare favorably with those of sulfapyridine. They further state that on the basis of superior margin of safety of sulfathiazol, and particularly sulfamethylthiazol, as compared with sulfanilamide and sulfapyridine, these new compounds appear quite likely to be useful.

Long and Bliss[16] conclude that sulfathiazol is as effective a bacteriostatic agent as is sulfapyridine in broth cultures on certain strains of hemolytic streptococci and staphylococci, but is, in their experiments, slightly less effective than sulfapyridine in the control of experimental pneumococcal infection. Long, Haviland and Edwards[17] conclude that sulfathiazol and sulfapyridine have about the same acute toxicity in mice and that this is about one-third greater than that of sulfanilamide. The acute toxicity was measured by the subcutaneous injection of the soluble sodium salts of the thiazol derivatives.

Van Dyke, Greep, Rake and McKee[18] found that the toxicity of sulfathiazol was about 65 per cent that of sulfapyridine, but that repeated administrations of the drug in food of mice indicate that sulfathiazol is more toxic than sulfapyridine at a high dose-level, but that there is no difference at a dose-level which is effective therapeutically. With both drugs the principal pathologic change appeared to be renal damage.

Since most of the interest in sulfanilamide and its allied compounds has been from the standpoint of those who administer the drug in therapeutic doses and obtain concentrations of about 10 mg. per cent in the blood stream, most of the work which has been done on the bacteriostatic action of these drugs has been undertaken with low concentrations and relatively little has been accomplished on the effects of high concentrations of the drugs. From the standpoint of wound infection, we are interested in the effect of the drugs on hemolytic streptococci, staphylococci and C. welchii, and we are interested in the effect of saturated solutions of the drug on these organisms. Our first interest is whether or not these drugs are bactericidal for these organisms *in vitro*, and since our wounds may be assumed to contain some peptone-like substances we want to know whether or not the drugs will kill bacteria in culture media which contain peptone.

In order to determine this, we carried out a few experiments with supersaturated solutions of the drugs, using 24-hour peptone broth cultures of *Staphylococcus aureus*, hemolytic streptococcus and C. welchii. The drug was first placed in the culture tube in excess, so that some drug was left in the bottom of the tube and this was left in the incubator for 24 hours. The tubes were inoculated and placed in the incubator. Some tubes were inoculated with one loop of a 24-hour broth culture and others with four loops and others with 1 cc. of the culture. The C. welchii cultures were incubated under anaerobic conditions. Since sulfanilamide is soluble up to about 1,000 mg. per cent and the other two drugs are soluble to slightly less than 200 mg. per cent, the concentration of sulfanilamide in the culture media was about five times that of sulfapyridine or sulfamethylthiazol. On the other hand, that is the condition which would exist in a wound which contained the drug in excess. The tubes were examined for turbidity and by smears and subcultures at the end of 24, 48 and 72 hours. It was found that the saturated solution of sulfanilamide completely sterilized the tubes containing the streptococci, but that the staphylococci and the gas bacilli grew, although they were inhibited during the first 48 hours. In the tubes containing sulfamethylthiazol and sulfapyridine, all of the organisms grew at the end of 24 hours, but were inhibited.

In the above crude experiments no bacterial counts were attempted, but it was evident that in broth containing 2 per cent of tryptose and supersaturated with the drug, the growth of all three organisms was definitely inhibited during the first 48 hours. This was true of each drug and even with heavy inoculations of bacteria. None of the drugs were bactericidal for staphylococci or C. welchii, and only sulfanilamide was bactericidal for strep-

tococci. Consequently, we believe that the drugs should be autoclaved before they are used in wounds. This may cause the powder to form lumps, but these can be crushed when used.

Jensen, Johnsrud and Nelson[1] produced compound fractures of the ribs in a series of 27 guinea-pigs and flooded the wounds with a culture of *Staphylococcus aureus*. The wounds were then sutured with silk. In seven control animals, 65 per cent of the wounds became infected and osteomyelitis developed in the ribs. In ten animals, 0.5 Gm. of sulfanilamide was implanted beneath the skin of the abdomen. Eighty per cent of the wounds in these animals became infected. In ten other animals in which sulfanilamide powder was placed in the wound before the wound was sutured, primary healing occurred in 80 per cent of the animals.

It was our intention in beginning this work to repeat the above experiments and to determine the relative efficiency of sulfanilamide, sulfapyridine and sulfamethylthiazol in preventing infection in contaminated compound fractures of ribs in a series of guinea-pigs. Unfortunately, we were not able to repeat the experiment, although we used four different strains of virulent hemolytic *Staphylococcus aureus*. In our guinea-pigs there was a high mortality from the fractures of the ribs, as we frequently penetrated the pleura and the animal then died. In our first experiments, the wound was flooded with a 24-hour broth culture of the staphylococcus and about 3 gr. of sulfanilamide, sulfapyridine or sulfamethylthiazol was implanted in the wound and it was sutured with silk. In 12 animals, only two wounds broke open (one with sulfanilamide and one with sulfamethylthiazol). These drained for a few days and then healed. The three control wounds which contained the bacteria, but no drug, healed by primary intention and remained healed.

We then tried the same experiment with rabbits, using a rabbit-virulent strain of staphylococcus obtained from Doctor Julianelle. The broth culture of this was swabbed in the wound after the rib had been fractured. The wound was then sutured. There were six controls and six wounds each with sulfanilamide, sulfapyridine and sulfamethylthiazol. About 5 gr. of the drug was placed in the wound before it was sutured. In this experiment the bacteria were grown on blood agar plates and were washed off with a small amount of salt solution and then swabbed into the wound. On the fourth day one wound containing sulfapyridine and another, containing sulfanilamide, were found to be broken open; the other wounds all healed. It is believed that the relatively large amount of the powdered drug in these two wounds acted as a foreign body and caused them to break open in the two instances in which this occurred, as the controls all healed.

In another experiment with 12 guinea-pigs, compound fractures of the ulnae were produced and the wounds swabbed with cultures of *Staphylococcus aureus* and sutured. In these experiments acacia plus glucose was added to the 24-hour broth culture before swabbing the wound with the material. Three of these animals were used as controls. In the other nine, the three above

mentioned drugs were placed in the wounds. One wound which contained sulfanilamide broke open on the fifth day; the others all healed.

In a fourth experiment, compound fractures of the ulnae were produced in rabbits and the wounds were saturated with virulent hemolytic *Staphylococcus aureus* plus acacia and glucose and then sutured, as were the guinea-pigs above. In five rabbits so treated, all wounds healed except one. This broke open at the end of five days and drained for several days and then healed. None of these rabbits had any drug placed in the wounds.

It is evident from the above experiments that we did not feel justified in drawing any conclusions as to the relative effects of the drug used, because in each of these four types of experiments our control animals failed to develop osteomyelitis, or even to develop sufficient local soft tissue infection to cause the wounds to break open.

We then decided to investigate the manner in which the tissues of experimental animals reacted to a local implantation of each of the above drugs. In order to study this, operations were performed upon a series of dogs, under general anesthesia, and approximately 7 gr. of sulfanilamide or of sulfamethylthiazol or of sulfapyridine was implanted in the wound. The wound was then sutured and the animal was sacrificed later and the wound was inspected locally; it was then excised and sectioned; the sections were stained with hematoxylin and eosin and studied microscopically. In this experiment, each drug was implanted into a joint and into a muscle, and the experiment was controlled by similar wounds in similar joints or muscles of the same animals. The shoulder, hip, elbow and ankle joints were used, and the operations were so spaced that when the animals were sacrificed we had 12 specimens at intervals of from one to 15 days after the implantation of each drug, and 12 controls of the same period.

On inspection of the wounds, we were not able to determine that any of the drugs caused any more inflammation or any more necrosis in the wounds and in the healing tissues than was present in the controls, with the exception that the wounds which contained the drugs and which were examined during the first few days after the operation tended to contain more fluid than the controls, and blood clots in these wounds were more gelatinous and less firm than those present in the controls. It is also to be noted that most of the wounds healed *per primam*, although in a few the skin edges separated. This separation of the skin edges did not occur with any more regularity in the wounds which contained the drug than it did in the controls, nor could any particular drug be incriminated as being prone to cause separation of the skin edges. At the time of our inspection of the gross wound it was not possible to identify any of the powdered drug, even after the short interval of 24 hours.

The microscopic sections failed to reveal any constant difference between the control wounds and the wounds which contained the drugs, except in the 24-hour wounds containing sulfapyridine and sulfamethylthiazol, where evidence of a few crystals was found in the microscopic sections. In other wounds the drugs had disappeared and the tissues seemed to be healing in

the normal way. In some of these, even in wounds which contained the drugs, there was a low grade infection present around the deeper sutures. These wounds contained deep sutures of silk which tended to render them more susceptible to infection, and in performing the operations little care was taken to prevent infection, as we wanted to determine whether or not we could, in this way, obtain some idea as to the relative efficacy of the drugs.

In the joints there was a low grade inflammation of the synovial tissues as a result of the operative incision. However, this did not seem to be sufficient to damage the joint seriously. The synovial lining cells were somewhat more numerous and larger and more youthful in appearance, and there was a moderate amount of infiltration of round cells and leukocytes in the specimens examined during the first ten days after the operation. At the end of the tenth or twelfth day, however, the synovial lining cells had returned to approximately their normal appearance and the infiltration of cells in the subsynovial tissues had almost entirely disappeared. It is to be noted that this low grade inflammation in the lining of the joints and the subsynovial tissues was no more marked in the joints in which either sulfanilamide or one of the other drugs had been placed than it was in the joints which had simply been opened and sutured. In other words, whenever a joint is opened and sutured, one may expect such reactions to occur in the synovial tissues. There was no evidence that the drug caused any damage to the surface of the articular cartilage, even though in these experiments the powdered drug was placed directly in the joints of the animal and then the wound sutured so that a considerable quantity of the drug was left in the joint.

It is thus evident from this series of experiments that either sulfanilamide or one of the newer preparations—that is, sulfapyridine or sulfamethylthiazol —can be placed in the tissues with impunity and it may be expected that they will not seriously harm healing tissues or prevent healing.

In a second series of experiments we attempted to investigate the effects of these drugs when injected into joint cavities and into other tissues and body cavities. These experiments were performed upon rabbits, and the drugs were injected into the peritoneal cavity, pleural cavity, knee joints and the subcutaneous tissues. In these experiments we used supersaturated solutions of the drug, that of sulfanilamide being approximately 1,000 mg. per cent while those of the sulfapyridine and sulfamethylthiazol were in the vicinity of 200 mg. per cent. We would, of course, have liked to use more highly concentrated solutions, but could not do so on account of the poor solubility of the drugs. It should be mentioned that both sulfapyridine and sulfamethylthiazol can be obtained as the sodium salt, which is very soluble, but these salts are very alkaline, having a p_H of about 11, and consequently are very irritating to the tissues; and we would not expect them to be tolerated either subcutaneously or in the body cavities. Consequently, they were not used.

In order to obtain a more highly concentrated solution we also used neoprontosil in 5 per cent and 2.5 per cent solutions. These experiments were

controlled by the injection of an equal amount of normal salt solution. They lasted only two days; that is, at the end of 24 and 48 hours after the injection the animals were sacrificed, and pieces of the lung, areas of the subcutaneous tissue which had been injected, pieces of the omentum and the synovial lining of the knee joint were excised and studied microscopically. In none of the animals were we able on macroscopic examination to see that the injection had done any harm, other than an occasional area which had been injured by the injecting needle where there was a small hemorrhage. Apparently, the tissues tolerated these substances equally well.

On microscopic examination of the knee joints, it was found that the synovial lining cells exhibited slight swelling and there was a slight amount of proliferation of the lining cells and also a slight amount of infiltration of round cells and leukocytes in certain loose areas of the subsynovial tissues. The pleural and peritoneal surfaces and the subcutaneous tissues presented even less departure from the normal than did the knee joints. These slight changes were also noted in the tissues and cavities which received normal salt solution and had largely disappeared on the second day. On the second day, the neoprontosil, which had been injected into the knee joints in 2.5 and 5 per cent solutions, was practically all gone and only a faint pinkish tinge remained. At the end of the first day, the knee was quite pink and the pink dye was seen spread out in the tissues all around the knee joint for considerable distances. It is further to be noted that neoprontosil injected into the joint appeared in the urine of the animal within a few minutes after the injection.

We also tested the absorption of the drugs in the subcutaneous tissues. In a series of eight rabbits, four small incisions were made in the skin of the back. The subcutaneous tissues were separated and about 5 gr. of the powdered drug was pushed well back under the skin and the wounds were sutured. The animals were sacrificed on the second, third, fifth, seventh, ninth, twelfth, twenty-first and twenty-eighth days after the operation. The neoprontosil, being quite soluble, was absorbed promptly and the powder had almost disappeared by the second day and was replaced by a gelatinous-like area of inflammatory tissue which disappeared in a few days. The sulfanilamide, being moderately soluble, was about half gone on the second day and practically all of it had disappeared on the fifth day, and the mild inflammatory reaction in the area was less than with the neoprontosil. The sulfamethylthiazol and the sulfapyridine, being relatively insoluble, remained as round, button-like masses in the subcutaneous tissues and there was very little reaction around them. Apparently these drugs were being encysted or surrounded by capsules, and their absorption was going on very slowly. At the end of five days, the sulfamethylthiazol and sulfapyridine remained about as in the two-day animal, while the more soluble neoprontosil and sulfanilamide had completely disappeared. In the animals examined at longer intervals, the two less soluble drugs were encapsulated, so that only a small encysted mass was present at the end of four weeks. A comparison of these experiments with those in which the drugs were implanted in wounds in muscles and in joints, indicates

that the circulation in the tissues surrounding the implantation of the drug has a good deal to do with the rate at which the drug will be absorbed. The rate also varies inversely with the solubility of the drug.

CONCLUSIONS

(1) Sulfanilamide, sulfapyridine and sulfamethylthiazol, in the form of powder, are well tolerated by the joints, muscles and connective tissues.

(2) In solution, they are well tolerated by the joints, pleura and peritoneum.

(3) They are bacteriostatic, but not bactericidal under the conditions present in a wound and should be sterilized before they are placed in a clean wound.

(4) They slightly inhibit the early healing of the wound, but do not unduly prolong the period of healing.

(5) Our experiments do not permit us to evaluate the efficacy of the drugs in preventing infection in contaminated wounds.

(6) *In vitro* observations, in the literature, suggest that local implantation, which assures a temporary high local concentration of the drug, is an effective method of preventing infection in clean and in contaminated wounds and of treating open infected wounds. Our clinical experience indicates that this is true.

(7) Due to its greater solubility we prefer sulfanilamide powder to either of the other drugs.

(8) We advocate the local implantation of sulfanilamide powder not only in contaminated wounds, but also in clinically clean operative wounds where infection is especially to be feared or would be especially undesirable.

REFERENCES

[1] Jensen, N. K., Johnsrud, L. W., and Nelson, M. C.: Local Implantation of Sulfanilamide in Compound Fractures. Surg., 6, 1–12, 1939.

[2] Lockwood, J. S.: Studies on the Mechanism of the Action of Sulfanilamide: III. The Effect of Sulfanilamide in Serum and Blood on Hemolytic Streptococci in Vitro. Jour. Immun., 35, 155–190, 1938.

[3] Fleming, A.: Observations on the Bacteriostatic Action of Sulphanilamide and M & B 693 and on the Influence Thereon of Bacteria and Peptone. Jour. Path. and Bact., 50, 69–81, 1940.

[4] Spink, W. W.: The Bactericidal Effect of Sulfanilamide upon Pathogenic and Nonpathogenic Staphylococci. Jour. Immun., 37, 345–358, 1939.

[5] Sadusk, J. F., Jr., and Manahan, C. P.: Sulfanilamide for Puerperal Infections Due to Clostridium Welchii. J.A.M.A., 113, 14–16, 1939.

[6] King, J. T., and Henschel, A. F.: Influence of Cultured Tissue Fragments on Sulfanilamide-Inhibition of Beta Streptococci. Proc. Soc. Exper. Biol. and Med., 41, 208–209, 1939.

[7] Carpenter, C. M., and Barbour, G. M.: Inactivation of Toxins of Staphylococcus Aureus and Clostridium Welchii in Vitro by Sulfanilamide. Proc. Soc. Exper. Biol. and Med., 41, 354–357, 1939.

[8] King, J. T.: The Effect of Sulfanilamide on Blood Leukocytes. Am. Jour. Physiol., 123, 119, 1938.

[9] Key, J. A., and Burford, T.: Local Implantation of Sulfanilamide in Compound Fractures; The Effect on Healing. Southern Med. Jour., (In Press).

[10] Bricker, E., and Graham, E. A.: The Inhibitory Effect of Sulfanilamide on Wound Healing. J.A.M.A., 112, 2593–2594, 1939.

[11] Barlow, O. W., and Homburger, E.: Specific Chemotherapy of Experimental Staphylococcus Infections with Thiazol Derivatives of Sulfanilamide. Proc. Soc. Exper. Biol. and Med., 42, 792–795, 1939.

[12] Rake, G., and McKee, C. M.: Action of Sulfathiazole and Sulfamethylthiazole on Staphylococcus Aureus. Proc. Soc. Exper. Biol. and Med., 43, 561–564, 1940.

[13] McKee, C. M., Rake, G., Greep, R. O., and van Dyke, H. B.: Therapeutic Effect of Sulfathiazole and Sulfapyridine. Proc. Soc. Exper. Biol. and Med., 42, 417–421, 1939.

[14] Lawrence, C. A.: Bacteriostatic Actions of Three Thiazol Derivatives of Sulfanilamide upon Bacteria in Broth Cultures. Proc. Soc. Exper. Biol. and Med., 43, 92–97, 1940.

[15] Barlow, O. W., and Homburger, E.: Thiazol Derivatives of Sulfanilamide and Experimental Beta Hemolytic Streptococcal and Pneumococcal Infections in Mice. Proc. Soc. Exper. Biol. and Med., 43, 317–323, 1940.

[16] Long, P. H., and Bliss, E. A.: Bacteriostatic Effects of Sulfathiazole upon Various Microorganisms. Its Therapeutic Effects in Experimental Pneumococcal Infections. Proc. Soc. Exper. Biol. and Med., 43, 324–327, 1940.

[17] Long, P. H., Haviland, J. W., and Edwards, L. B.: Acute Toxicity, Absorption and Excretion of Sulfathiazole and Certain of Its Derivatives. Proc. Soc. Exper. Biol. and Med., 43, 328–332, 1940.

[18] Van Dyke, H. B., Greep, R. O., Rake, G., and McKee, C. M.: Observations on the Toxicology of Sulfathiazole and Sulfapyridine. Proc. Soc. Exper. Biol. and Med., 42, 410–416, 1939.

DISCUSSION.—DR. KELLOGG SPEED (Chicago, Ill.): I should like to corroborate some of these findings and suggestions of Doctor Key. I have used sulfanilamide in some dozen clinical cases, and we have found that there is an increased amount of serous discharge from the wounds without a definite delay in the healing. I think the question of drainage of the wound has a lot to do with the keeping of the concentration of the drug locally, and we have found it of greatest use in secondary amputations, and in the removal of septic stumps where one wishes to close the area tightly in an attempt to obtain early healing. We take a small handful of the drug, without measuring its quantity, and place it directly in the closed stump. These have done very well with, as I said, prolonged serous discharge. We have found no evidence, clinically, of untoward reaction in the tissues of such wounds.

We have also used, in definitely septic wounds which may contaminate bone or joint, irrigations of 4 per cent solution of sulfanilamide. This we find reduces the bacterial count, but does not completely sterilize the wound in any way. It does seem, in cases that have been observed as long as three months, to minimize the amount of new bone formation or osteogenetic reaction.

Within the last ten days, I have been in Pittsburgh, where they have a large number of infected, compound wounds involving bones and soft tissues, and I find that they are there using sulfathiazol to considerable advantage, placing in the wound, every day, a small amount of the powder at the time of dressing. They are unable, from my observation, to make any definite statement about its final value, and I believe that the question of drainage and the amount of freedom with which the secretion may run out of the wound has a great deal to do with its action.

DR. FRANK L. MELENEY (New York, N. Y.): I do not feel that I have any right to say anything about the clinical use of these drugs in crystalline form as my experience has been very limited. I have used them almost entirely by mouth or intravenously, but I should like to mention a few points

in Doctor Key's paper, and I hope that he will not mind if I find some faults with the experimental work.

First, his experimental set-up does not simulate clinical conditions. The subject of his paper being "contaminated wounds," I hardly think it is fair to limit the bacterial contamination in his experiments to the staphylococcus. I presume that he is considering principally traumatic lesions, such as accidental wounds, and we know that they are contaminated with a number of different organisms, the staphylococcus, of course, being one, almost invariably, but the hemolyticus streptococcus and the anaerobic bacteria are perhaps of more importance. Of course, in accidental wounds, the organisms are probably present in very much smaller numbers and may have a symbiotic effect which pure cultures will not have. In other words, he should have contaminated his experimental wounds with mixtures of organisms commonly found in accidental wounds.

I also think that he should have taken into consideration the trauma that exists with accidental wounds, and similarly traumatized his experimental wounds.

Of course, one of the prime requisites of proper treatment of accidental wounds is the removal of all injured tissue, foreign bodies, *etc.*, but in most wounds that are so treated there is still some damaged tissue remaining after débridement. We know that the sulfanilamide group of drugs, even under the best conditions in the test tube, do not have a bactericidal action and only have a bacteriostatic action if the organisms are present in very small numbers. Furthermore, they are particularly inactivated by injured tissue.

I think it is very difficult to produce experimentally, in animals, conditions similar to those which exist in human wounds clinically. Therefore, it is very difficult to draw conclusions from animal experiments of this kind and I do not think that Doctor Key's results justify the conclusions at which he has arrived. After all, perhaps the most important point I can make is that the final evaluation of these drugs will have to be made from clinical observation of a great many cases. I think it should be kept in mind, however, that if crystals are put into wounds they do act as foreign bodies and, to that extent, are not only irritating but mechanically separate the wound surfaces. Furthermore, there is always the possibility of toxic effects which should be kept in mind and carefully studied if any clinical experiments are to be recorded.

Finally, let me make a plea for adequate bacteriologic studies in these clinical investigations. There should be a complete bacteriologic analysis of the flora, both aerobic and anaerobic, of all wounds treated either locally or generally with these drugs. Then we will learn what these drugs will really do against every species and every combination.

DR. OWEN H. WANGENSTEEN (Minneapolis, Minn.): I wish to speak briefly concerning the value of local implantation of sulfanilamide about the operative site in experimental gastro-intestinal surgery upon the dog. There has been a lively local interest relating to the implantation of sulfanilamide in wounds since Dr. N. K. Jensen, of the Minneapolis General Hospital, and his associates first pointed out the efficacy of employing sulfanilamide in this manner as a bactericidal and bacteriostatic agent.

During the current year, Dr. Richard L. Varco has made a very interesting application of the use of local implantation of sulfanilamide. Upon completion of gastro-intestinal anastomoses of varying kinds, Doctor Varco has been placing 4 to 5 Gm. of sulfanilamide about the suture. He has now an operative series of between 40 and 50 operations, many of which involve

triple anastomoses, such as the interpolation of a short segment of the terminal ileum and ascending colon between the pyloric outlet and the jejunum to imitate the function of the Dragstedt valve, with transfer of the biliary and pancreatic secretions to a lower level in the bowel (duodenal drainage according to the Mann-Williamson method), transection and end-to-end anastomosis of the esophagus, the establishment of Pavlov gastric pouches, gastric resections and similar procedures with only three deaths in the group (none with peritonitis).

This is really an unusual accomplishment for any surgeon. Markowitz, a pupil of Frank Mann, has said quite appropriately: "If an operator has mastered the technic of resection in dogs, he need not doubt his ability to make a safe anastomosis of the human intestine. When a surgeon can perform on dogs the operation of functional exclusion of the duodenum, known as 'duodenal drainage,' with a mortality of only 20 per cent, we should say that he has mastered the technic of intestinal anastomosis" (Experimental Surgery. William Wood and Company, 1937, p. 73).

The difficulties in the dog are well-known to all who have had an extensive experience in this type of surgery. Doctor Varco and I have been able to confirm Markowitz's observation, and from my own experience, I have the impression that similar anastomoses on man may be carried out with definitely lesser risk.

Even with employment of closed or so-called "aseptic" anastomoses in the dog, leaks may occur where the intestine is punctured with the needle, even though fine needles and silk are used. It is very discouraging to spend three to four hours making a complicated anastomosis in the dog to find, in 48 hours, that the anastomosis appears to leak in many places, particularly when everything seemed in order on completion of the procedure.

It is Doctor Varco's impression that the local implantation of sulfanilamide about the anastomosis exerts a bacteriostatic effect upon the bacteria which escaped through needle punctures of the intestinal wall. The presence of pathogenic bacteria on the peritoneal surfaces of the anastomosed segments, Doctor Varco feels, interferes with fibrin formation and stops the healing process. Local implantation of sulfanilamide holds the bacteria in check, preventing the lysis and destruction of fibrin, thus permitting the healing process to continue normally. Doctor Varco failed to observe a similar protective influence when the sulfanilamide was administered subcutaneously.

It is well known that the dog tolerates relatively larger doses of sulfanilamide than does man. Further, the dog does not acetylate a portion of sulfanilamide administered, as does man. Consequently, in the dog, all of it is available for bactericidal and bacteriostatic purposes. We have used sulfanilamide in this manner in colon resections, implanting usually 4 Gm. about the anastomosis and 2 Gm. in the abdominal wall above the peritoneum. The blood levels of sulfanilamide in man, following such implantation, come up to maximal levels in two to three hours' time. If the sulfanilamide could be implanted locally in oil, permitting even slower absorption, the protection afforded might be enhanced. It does appear that local implantation of sulfanilamide in the peritoneal cavity of the dog, about complicated gastrointestinal anastomoses, is a worthwhile procedure.

DR. J. DEWEY BISGARD (Omaha, Neb.): I would like to report some experimental work which we have carried out similar to that just reported. Our results, as far as soft tissue healing was concerned, were exactly as those reported, but we also carried out observations relative to the healing of fractures, and we found that the healing of fractures in the presence of large

quantities of sulfanilamide (these were all carried out with sulfanilamide) progressed at a perfectly normal rate and there was as prompt healing in those in which there was sulfanilamide present and as thorough healing as those of the controls.

DR. HENRY F. GRAHAM (Brooklyn, N. Y.): Experimental work is valuable, but we should not forget the clinical side also. Many of us are clinical and not experimental surgeons. We should not forget the work that Doctor Garlock has done: He demonstrated, in his large colon surgery, that he could perform 25 operations in succession with a little skin infection in one only by the use of sulfanilamide by mouth or subcutaneously. We must not forget the article of Ravdin's, which came out in the January number of the ANNALS OF SURGERY, on the use of sulfanilamide subcutaneously in ruptured appendicitis cases and the remarkable results that he has obtained by its use subcutaneously.

We, personally, were interested in that, and within a few days after that article appeared a four-year-old child was brought into the hospital with a ruptured appendix and a large amount of fecal matter in the abdomen. The appendix was removed, a tube was inserted, and sulfanilamide was immediately started subcutaneously. No sulfanilamide was used locally in the wound or in the pelvis. Inadvertently, about the third day after the operation, this child reached under her dressings and pulled the tube out—and it was never reinserted. She went on to a complete recovery without any secondary operation.

We had a man with a ruptured appendix, and a fulminating peritonitis, and great abdominal distension. For days, he got sulfanilamide subcutaneously, and at autopsy—he died of pneumonia—there was no evidence of any peritonitis whatsoever. It had entirely cleared up.

We began by using sulfanilamide subcutaneously but found that the cost was prohibitive in the ampules, so, finally, in looking over a Winthrop Chemical Company pamphlet, we found that if the powdered sulfanilamide was thrown into water which had been brought to a boil and then taken off the stove or the heater it was not disintegrated, and we have been using it since that time in that way. We throw the 8 Gm. into the liter of boiling water. That makes a day's dose for an ordinary individual, we will say of average weight, 150 or 160 pounds. The first dose usually consists of 4 Gm. to bring the blood sulfanilamide to the proper level, and then it is continued every six hours thereafter hypodermically and we have found it very efficient. It gives a blood level of about 7 mg. per cent.

In several instances, where we have had tubes for drainage, we have taken the drainage from the tubes and have estimated the sulfanilamide concentration and have been able to get a concentration of 7 to 8 mg. per cent in the pus and discharge from the tubes. This local use may be valuable, but it remains doubtful, as yet, whether the introduction of a foreign body directly into the wound is better than its subcutaneous or oral administration.

DR. J. ALBERT KEY (St. Louis, Mo., closing): I agree that it is of value subcutaneously. I think it is of more value implanted locally, however, because the concentration is greater. I wish there were some way that we could produce a uniform local infection in animals. Until we can obtain a uniform local infection in animals I do not know how we are going to test out the efficacy of drugs on such an infection.

In regard to the trauma to tissues in compound fractures, before you put in sulfanilamide you perform just as careful a débridement as you would

if you were not going to put in sulfanilamide. The idea of the sulfanilamide is that it is probable that a very mediocre surgeon can obtain just as good results or better with it than can the best surgeon without it; at least, that is my opinion.

We heard last night about the work in Spain. Many of you may have read Trueta's report of that work. I believe that his method has been adopted by the British Medical Association. I had some correspondence with Dr. T. P. McMurray and he was quite enthusiastic about Trueta's work. There is nothing new about it. Doctor Gurd showed a similar method to the American Orthopedic Association when they met in Toronto several years ago. He débrided compound fractures very thoroughly, taking out all questionable tissue, and used a very thin layer of "Bipp" on his wounds after getting them as dry as he could and then put on a plaster encasement. In Spain they have used gauze. I believe that if they had used sulfanilamide most of those same wounds could have been closed. It would have saved a tremendous amount of after-care, it would have saved scars, and the results would have been much better.

In regard to the foreign body reaction, that is the reason we prefer sulfanilamide to the other two drugs. We take care that we do not put in lumps of the drug. You can crush it in your fingers, as it clumps up after being sterilized, and scatter it thinly over the surface. Then I usually rub it over with my fingers. I do not think it lasts long enough as a mass to create sufficient foreign body reaction to be objectionable.

In regard to bone healing, I have used it routinely in bone grafts for the past year or more and have not had any trouble.

In regard to toxic effects of the drug, in the literature, the fatalities have come late in the course of treatment in people who have received from 34 to 100 Gm. of the drug. There have been no fatal toxic effects from amounts comparable to those used in wounds.

Doctor Harbison and I have been working on the healing of the stomach and intestinal wall since Doctor Graham and Doctor Bricker showed that with therapeutic doses of sulfanilamide there was some slight delay in wound healing. I think that we will find that probably there will be a little delay, but we still do not believe that this delay is going to be sufficient to contraindicate the use of the drug.

DEGENERATION AND RECOVERY OF AUTONOMIC NEURONS FOLLOWING ALCOHOLIC BLOCK

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PARAVERTEBRAL INJECTION of alcohol to produce functional interruption of autonomic conduction pathways has become a recognized therapeutic procedure. It has been employed in many cases as a substitute for sympathetic ganglionectomy. Clinical reports indicate that it is useful not only in the treatment of diseases in which exaggerated vasomotor tonus exists at the periphery, but also in the relief of visceral pain. Actual investigation of the histologic and cytologic changes which take place in the autonomic nerves and ganglia following alcohol injections have not hitherto been carried out. The present investigation has been undertaken to determine what changes take place in the nerves and ganglia in question, whether nerves may be blocked permanently by means of alcohol injections, and under what conditions restoration of function may be expected.

Mandl[2] (1925) advocated blocking of sympathetic ganglia and fibers by injection of procaine hydrochloride in proximity to the sympathetic trunk ganglia in patients suffering from angina pectoris. Swetlow[8] (1926, 1930) reported successful use of alcohol injections after diagnostic use of procaine for more permanent relief from pain in such cases. Mixter and White[3] (1928), White and White[10] (1928), and White[9] (1930) also successfully treated patients with angina pectoris by this method. In summarizing the results of the first 35 cases treated in this way at the Massachusetts General Hospital, White[9] (1935) found that 67 per cent obtained almost complete relief, 25 per cent showed moderate to marked improvement, and 9 per cent showed no improvement. According to Smithwick[6] (1937), paravertebral injection of alcohol is as satisfactory in the treatment of angina pectoris as any operation of this magnitude, and has become the treatment of choice.

Stern[7] (1930) and Patterson and Stainsby[4] (1936) reported definite improvement in cases of thrombo-angiitis obliterans of the lower extremities following alcohol injections of the upper third or fourth lumbar segments. In patients with Raynaud's disease, Flothow[1] (1931) and Patterson and Stainsby (1936) observed immediate results as good as those following sympathectomy. Reichert[5] (1933) reported 25 cases of intermittent claudication without gangrene which were materially benefited by paravertebral injection of alcohol following the diagnostic use of novocain. In cases of polyarthritis which showed vasomotor disturbances, Flothow (1931) and

Submitted for publication May 18, 1939.

Patterson and Stainsby (1936) reported relief from pain and improvement in joint function and in the symptoms related to faulty circulation.

Materials and Methods.—Cats have been used exclusively in this investigation. Nerve block was produced by injecting, with a syringe, 2 to 5 cc. of 95 per cent ethyl alcohol into the region of the ganglion or ramus to be blocked. Paravertebral and direct injections were employed. In the former method, the needles were inserted in the back, using the vertebral spine as guides. In the latter, the lumbar and cervical ganglia and rami were exposed by means of incisions through the skin and underlying tissues, and directly injected. This procedure was used almost exclusively in the later part of the work, since it was found that the percentage of successful paravertebral injections was low, whereas the desired results were obtained almost constantly by direct injection.

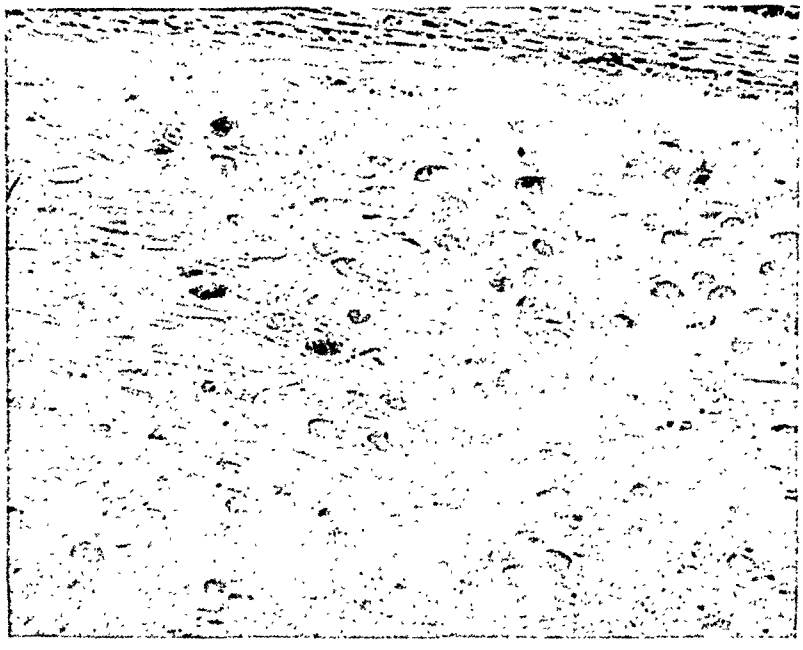


FIG. 1.—A section of a completely infiltrated sympathetic trunk ganglion removed after three days, showing the dead neurons and the absence of live interstitial cells in the area of infiltration. (×100)

The lumbar sympathetic ganglia and rami were used for the study of degeneration and regeneration of ganglion cells and postganglionic fibers following nerve block; the cervical sympathetic trunk was used for the study of the changes in the preganglionic fibers. To demonstrate the functional state of the blocked preganglionic fibers, faradic stimulation was applied to the cervical trunk between the site of injection and the stellate ganglion. The absence or presence of eye responses was correlated with the histologic findings.

The pyridine silver technic was used to demonstrate changes in ganglion cell bodies and their processes; the erythrosin-toluidine blue technic to demonstrate chromidial and nuclear patterns; and the osmic acid technic to demonstrate changes in myelin sheaths.

Histologic and Experimental Data.—Changes in Ganglia and Associated

Rami Infiltrated with Alcohol: Infiltrated ganglia, removed three days after injection and stained with erythrosin-toluidine blue, show marked degenerative changes (Fig. 1). The entire section reacts lightly to the acid stain and not at all to the basic stain. The only evidence of living cells is in the connective tissue surrounding the ganglia. The shrunken neurons show no cytologic structure except a very pale spherical nucleus. The widely dilated capillaries contain only fragmented blood cells making it evident that no blood flows through the infiltrated tissue. The histologic appearance closely resembles that of a recent infarct.

Occasionally, even though the ganglion is affected directly by the alcohol, the reaction is less intense, probably due to dilution of the alcohol by the

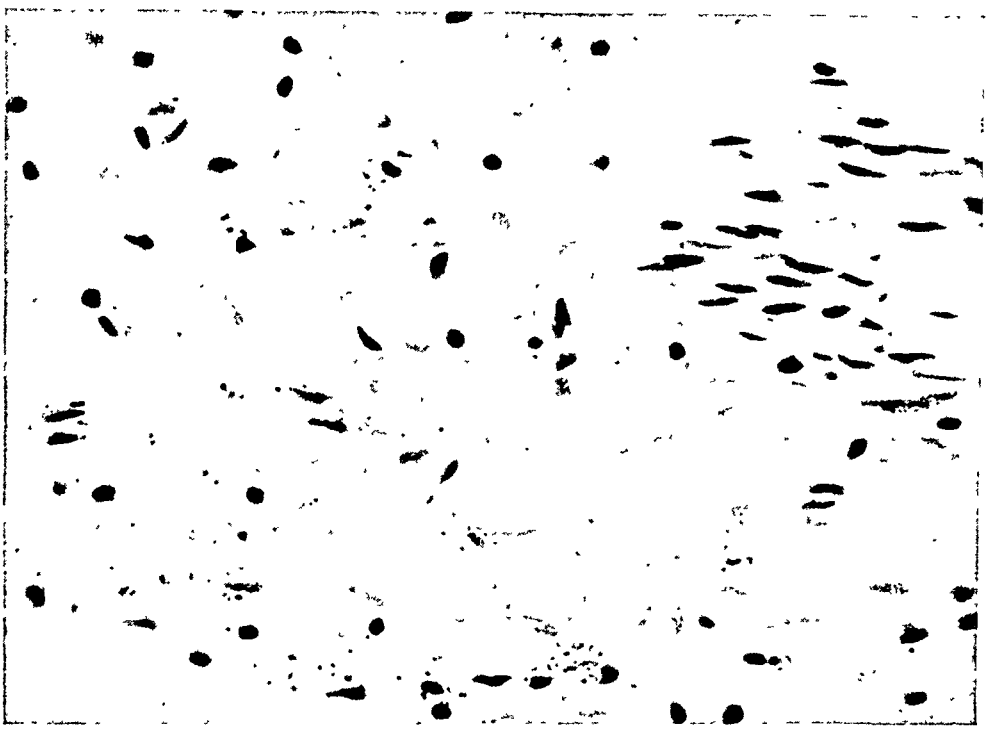


FIG. 2.—A section of an incompletely infiltrated ganglion removed after three days. The neurons have been killed but the more resistant interstitial cells have survived. (×400)

tissue fluids before it penetrated the ganglion, when the point of the needle was not sufficiently close to it. Under such conditions, the neurons seem to be the only cells affected. The remaining cells stain normally, the sheath cells being especially prominent (Fig. 2). Of all the cells in the ganglion, the neurons seem to be the most susceptible to the injurious effects of the alcohol, while the sheath cells are comparatively resistant.

Within the infiltrated rami of a blocked ganglion, the only tissue elements apparently intact are the connective tissue fibers of the endoneurium and perineurium. No cellular elements are visible except beyond the limits of the area of infiltration, where it is evident that the distal portions of the injured axons are undergoing typical wallerian degeneration.

Infiltrated ganglia retain the characteristics described above until after approximately 25 days, at which time cells, most of which are sheath cells, fibroblasts, and histiocytes, are found migrating into the necrotic area from the associated uninfiltrated rami. This is the only path by which cells can invade the tissue, since no functioning blood vessels are present. Wherever the invading cells are found in the ganglion, the neurons have either disappeared completely or are in a state of fragmentation. These necrotic neurons obviously are phagocytized by the invading cells. This phagocytosis is comparatively rapid as evidenced by the fact that very few neurons are present in the area occupied by the free cells (Fig. 3). Small blood vessels



FIG. 3.—A section of a completely infiltrated ganglion removed after 30 days, showing phagocytosis of the dead neurons by the cells migrating into the area from an associated ramus. (×100)

grow into the tissue along with the migrating cells and reestablish circulation in the area.

In ganglia which are incompletely infiltrated, the ganglion cells undergo phagocytosis earlier than in those in which infiltration is complete. The cells of the interstitial tissue, being more resistant than the neurons, are not killed; consequently, phagocytosis of the ganglion cells begins at once, whereas, if infiltration is complete, phagocytic cells must first wander in from the uninfiltrated area.

In ganglia and rami removed 40 to 60 days after infiltration and stained with erythrosin-toluidine blue, the infiltrated region is distinguishable because of the light pale appearance of the tissue. Large phagocytes and young fibroblasts are present in abundance, but neurons are lacking (Fig. 4). At

approximately 40 days, silver preparations show a loose tangled skein of fibrils and collaterals of regenerating axons within the scar tissue at the site of injection. This is probably due to the absence of protoplasmic bands of sheath cells, and to the density of the connective tissue of the scar. By 60 days, however, sheath cells have become arranged in definitive protoplasmic bands in which regenerating fibers grow through the ganglion in more or less direct courses. It is evident, therefore, that some of the early regenerating fibers are lost in the scar tissue, due to the absence of previously established pathways, while later ones grow along the newly formed protoplasmic bands and reach the peripheral segments.

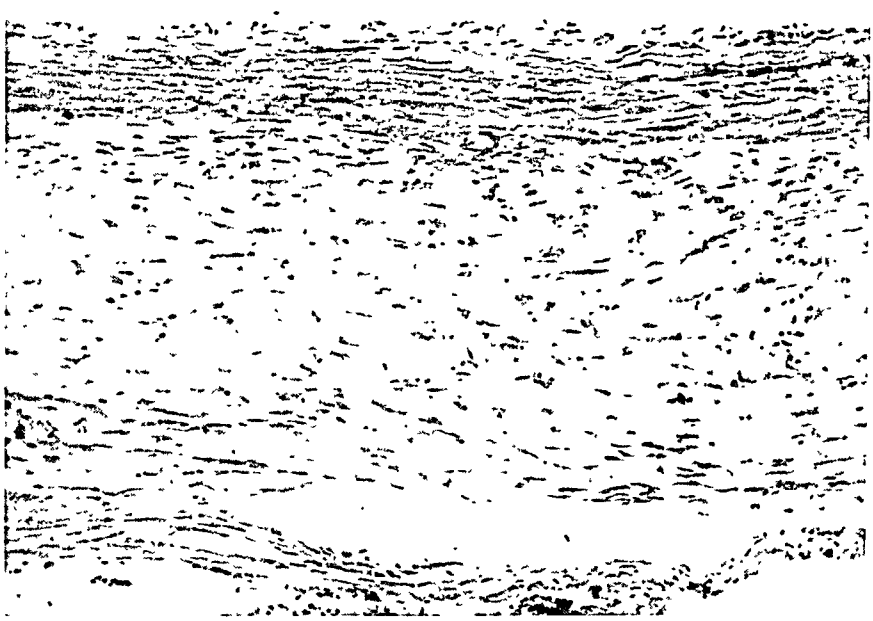


FIG. 4.—A section of the connective tissue mass which represents a completely infiltrated ganglion after 40 days. (×100)

Changes in Rami Alone Infiltrated with Alcohol.—Blocking preganglionic fibers by infiltrating the communicating rami does not directly affect their cells of origin, since the latter are located within the spinal cord. Postganglionic fibers may also be blocked in this manner without directly affecting the ganglion cell bodies, especially since the ganglia of the sympathetic trunk are more resistant to the effects of alcohol than the rami. The degeneration of the axons of both preganglionic and ganglionic neurons distal to the site of injection, as has been stated above, is typically wallerian. The accompanying retrograde reactions in the cell bodies are apparent as early as three days after injection and increase in severity. In preparations taken 25 to 50 days after infiltration, many of these cells are dead or dying. They show marked turgescence, absence of nuclei, and acidophilic cytoplasm with marked neuronophagia. Of the remaining neurons, some apparently

are normal, some show extreme chromatolysis, and some, other regenerative changes.

These changes are observed up to 90 days after infiltration, at which time most of the remaining cells either are normal or show characteristic evidence of recovery. The decrease in the number of ganglion cells present causes the remaining neurons to be more widely separated from one another than in a normal ganglion.

Changes in Preganglionic Fibers of the Cervical Sympathetic Trunk Infiltrated with Alcohol.—Infiltrated portions of the cervical sympathetic trunk removed within a few hours after injection of alcohol show beginning dissolution of the myelin. After ten days, myelin degeneration at the site of injection goes on more rapidly than in the remaining portions of the trunk. Only small globules of myelin remain. Distal to this area, the myelin seems to follow the usual process of degeneration which takes place when an axon is severed from the cell body.

Regeneration of the myelin is very apparent at 90 days, at which time it is present on the regenerating axis cylinders for variable distances. The process once initiated is so rapid that in sections of the trunk taken at the inferior border of the superior cervical ganglion 170 days after injection the myelin sheaths are completely regenerated.

Duration of Cervical Sympathetic Block as Determined by Faradic Stimulation.—Within a few minutes after injection of the alcohol to produce block of the cervical sympathetic trunk, the effects upon the eye can be noted. The pupil is constricted and the nictating membrane extended. This syndrome signifies blockage of the nerve impulses, but to further test the completeness of the block faradic stimulation was applied to the trunk between the area injected and the inferior cervical ganglion.

In the one cat which was allowed to live 170 days after block was produced, the eye syndrome was still apparent but in reduced degree. When faradic stimulation was applied to the lower portion of the cervical sympathetic trunk, the pupil slowly dilated and the nictating membrane receded. These responses were considerably slower than in normal cats, but they demonstrate that functional connections in the superior cervical ganglion have been at least partially reestablished in 170 days.

SUMMARY AND CONCLUSIONS

The histologic and cytologic changes in the autonomic ganglia and nerves of cats following exposure to alcohol either by paravertebral injections of the sympathetic trunks or by direct application have been described. The changes which occur after infiltration of a ganglion differ from those which occur after infiltration of the rami. When a ganglion is infiltrated, a permanent block to all effectors innervated by the postganglionic fibers taking origin from it is produced, since the alcohol kills the ganglion cells. Phagocytic cells migrate into the infiltrated area from the adjacent uninfiltrated rami and remove the necrotic ganglion tissue. After 35 days there remains only a

connective tissue scar. When the rami alone are infiltrated, a temporary block is produced. The alcohol affects the axons at the site of infiltration by partially dissolving the myelin, if the fibers are myelinated, and interrupting the continuity of the axons so that the distal segments undergo typical wallerian degeneration. Retrograde changes also occur in the related cell bodies which cause some of the neurons to undergo complete degeneration; others suffer injury in lesser degree and eventually recover.

The nerve tissue in the area of infiltration may be completely destroyed, yet the fibrous elements of the connective tissue maintain the continuity of the ramus. Block of this type is less permanent than that produced by

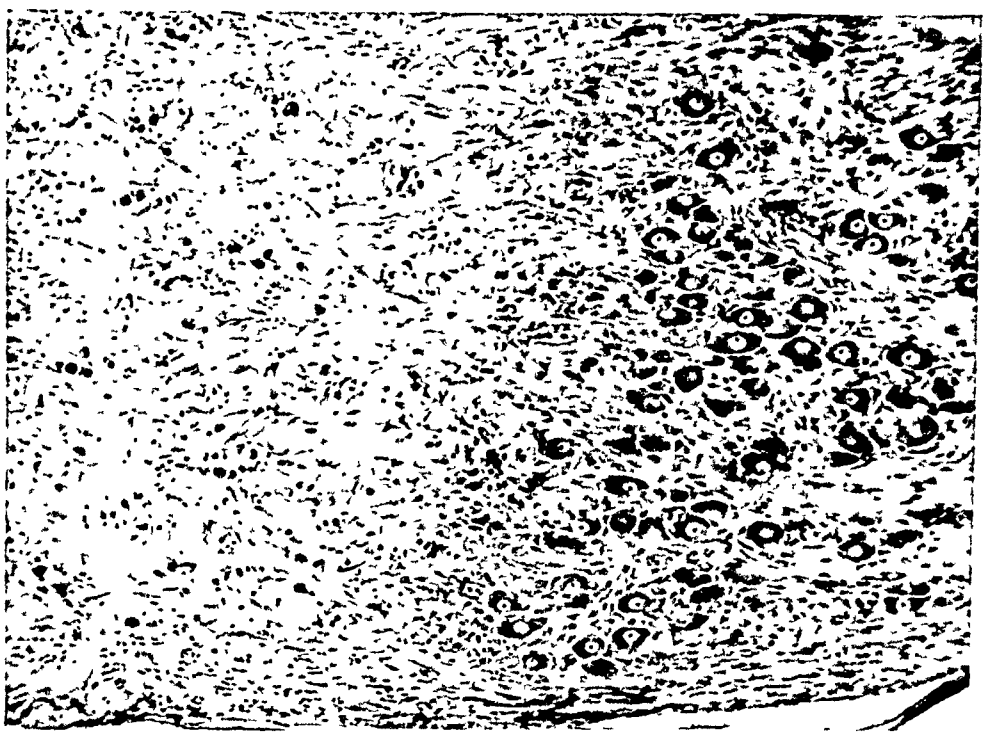


FIG. 5.—A section of a ganglion removed after 30 days, in which infiltration was only partial. Approximately one-half of the ganglion cells have been killed and phagocytized. (×100)

section of a ramus since, in the latter case, regenerating axis cylinders may span the gap between the proximal and distal segments of the ramus in order to reach the protoplasmic bands formed by the sheath cells of the distal segment. When a nerve is blocked by injection of alcohol, no gap is produced although a connective tissue scar is formed at the site of infiltration. Fibers penetrate this scar relatively early and with ease so that functional connections are established much sooner than following section of the nerve

In order to produce permanent sympathetic nerve block by means of paravertebral alcohol injection, the ganglia must be infiltrated. If the needle is not inserted deeply enough, only the communicating rami may be affected, since the alcohol diffuses only slightly through the tissues. In the present investigation, infiltration of ganglia was affected only when the alcohol was

injected in their immediate vicinity. In some cases, only the rami were infiltrated even though the alcohol was injected close to the ganglia. In other cases, the infiltration was not sufficiently extensive to destroy all the ganglion cells (Fig. 5). These results indicate that the point of the needle must be practically adjacent to the ganglion or even penetrating it in order to insure complete infiltration. On the other hand, block of the rami is accomplished relatively easily. The variability of the results obtained by paravertebral injection in clinical cases may be explained at least in part on this basis.

Permanent block of sympathetic impulses to abdominal viscera by means of paravertebral injections of alcohol is impossible, since most of the neurons from which postganglionic fibers to these organs are derived are located in the prevertebral ganglia. The preganglionic fibers to these ganglia may be blocked by this technic but they are not prevented from reestablishing functional connections with the ganglion cells in question in a relatively short time. On the other hand, permanent and complete block of sympathetic impulses to the thoracic viscera or the extremities may be produced by paravertebral injection, since infiltration of the sympathetic trunk ganglia destroys the cells of origin of the postganglionic fibers involved.

The author is indebted to Dr. Albert Kuntz for helpful suggestions and criticisms throughout this investigation.

REFERENCES

[1] Flothow, P. G.: Diagnostic and Therapeutic Injection of the Sympathetic Nerves. Am. J. Surg., 14, 591–604, 1931.

[2] Mandl, F.: Die Wirkung der paravertebralen Injektion bei Angina pectories. Arch. f. klin. Chir., 136, 495–518, 1925.

[3] Mixter, W. J., and White, J. C.: Alcohol Injection in Angina Pectoris. ANNALS OF SURGERY, 89, 199, 1928.

[4] Patterson, P. H., and Stainsby, W. J.: The Therapeutic Effects Following Interruption of the Sympathetic Nerves. Report on the Alcohol Block in Certain Arthritic and Vascular Cases. ANNALS OF SURGERY, 103, 514–534, 1936.

[5] Reichert, F. L.: Intermittent Claudication Without Gangrene Controlled by Sympathetic Nerve Block. ANNALS OF SURGERY, 97, 503–507, 1933.

[6] Smithwick, R. H.: Value of Sympathectomy in Treatment of Vascular Disease. New Eng. J. Med., 216, 141–150, 1937.

[7] Stern, E. L.: Alcohol Injection of Nerve Roots for Thrombo-Angiitis Obliterans. Preliminary Report of 3 Cases Definitely Improved. Am. J. Surg., 10, 107–115, 1930.

[8] Swetlow, G. I.: Paravertebral Alcohol Block in Cardiac Pain. Am. Heart J., 1, 393–412, 1926.

Idem: Angina Pectoris: Paravertebral Alcohol Block for Relief of Pain. Am. J. Surg., 9, 88–97, 1930.

[9] White, J. C.: Angina Pectoris; Treatment by Paravertebral Alcohol Injection or Operation Based on Newer Concept of Cardiac Innervation. Am. J. Surg., 9, 98–105, 1930.

Idem: The Autonomic Nervous System. The Macmillan Co., New York. Chap. XXI, 364–375, 1935.

[10] White, J. C., and White, P. D.: Angina Pectoris: Treatment with Paravertebral Alcohol Block. J.A.M.A., 90, 1099-1103, 1928.

BRIEF COMMUNICATIONS AND CASE REPORTS

ANGIOMA OF THE SKULL

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ANGIOMA OF THE SKULL is not a common condition as a careful review of the literature reveals only 26 cases. Of 1,831 neoplasms of the bone recorded in the bone registry, 13 have been hemangiomata. Of these only three involved the skull. In Christensen's[1] collection of 918 neoplasms of the bone, less than 1.5 per cent were hemangiomata. Geschickter and Copeland[2] report 12 cases of hemangioma of all types of bone in a group of 1,700 neoplasms of bone. These authors have called attention to the fact that most of the earlier reports failed to distinguish hemangioma from sarcoma and, in



FIG 1.—Roentgenogram showing a bulging, soft tissue mass in the right frontal region.

1937, I[3] reported a case of angioma of the skull which was successfully removed, and there has been a total of nine tumors which were extirpated. Some authors have felt that roentgenotherapy or irradiation was the procedure of choice because of the extreme vascularity of the bone. There are two types, cavernous and capillary angiomata. The cavernous angioma is filled with large blood spaces resembling a cavernous angioma elsewhere in the body. The capillary type is one in which there are many small openings

Submitted for publication October 7, 1939.

filled with blood and interspaced with a great deal of fibrous tissue. The first case of this series was of the capillary type.

Toynbee,[4] in 1845, was the first to describe angioma of the skull and, since then, there have been various references to this condition. The most recent has been the case reported by Anspach,[5] of a girl, age 11, who registered at the Children's Hospital in Chicago, in 1921, but the condition was deemed inoperable because of the extreme vascularity, and 15 years later she returned for irradiation. Irgens[6] reported an hemangioma of the skull involving the right petrous and occipital bones, which succumbed nine months after exploration and irradiation.

The basis of this report is the author's second case, which differs from the first in the fact that it was a cavernous hemangioma, and it was, also, successfully removed.

TABLE I

RÉSUMÉ OF ANGIOMATA OF THE SKULL AND ASSOCIATED LESIONS REPORTED BY VARIOUS AUTHORS

Author	Age	Sex	Location	Remarks
Toynbee[4]	19	M.	Parietal bone.	Died of tuberculosis.
Ehrmann[7]	40	F.	Left parietal bone.	Removal. Died of meningitis.
Cruveilhier[8]	38	F.	12 angiomata of skull; one of femur; one of third rib and one of both shoulders.	No details given.
von Rokitanski[9]			Angioma of parietal lobe.	None.
Morris[10]			Right parietal bone eroded.	Removal.
Stamm[11]	4 mos.	F.	Angioma; skin, muscles, bone, kidney, ovary, lungs, brain and skull.	Found at autopsy.
Pilcher[12]			Angioma; vault of skull.	Removed.
Ziegler[13]			Angioma of skull.	
Zajaczkowski[14]	38	F.	Frontal bone.	Removal. Tumor pulsated in center.
Schöne[15]	39	M.	Angioma: occipital bone.	Removal with recovery.
Major and Black[16]	34	M.	Angioma: each temporal bone.	Also angioma: liver and bilateral cystic adrenals found at autopsy.
Brandt[17]	47	M.	Angioma: left petrous bone.	Found at autopsy; also angioma: retina of right eye, cerebellum, cauda equina, kidneys, pancreas, spleen and questionably in the long bones. This was a report of von Hippel's case.
Kaufman[18]	76	M.	Angioma of skull.	Found at autopsy.
Cushing[19]	26	F.	Right parietal bone.	Successfully removed.
Lanari and Marque[20]			Two cases of angioma of skull.	Treated successfully with roentgenotherapy.
Frös[21]	70	F.	Angioma of frontal bone. In addition, multiple small angiomata of other cranial bones.	Found at autopsy.
Overend[22]		M.	Angioma of occipital bone.	Demonstrated roentgenologically and removed.
Geschickter and Copeland[3]			Five angiomata of skull.	One congenital angioma removed from skull and scalp of a 17 mo.-old female. Inner table of the skull intact.
Abbott[2]	3	F.	Angioma of right frontal area.	Successfully removed.
Anspach[5]	11	F.	Angioma of the left parietal region.	Not removed. Treatment with radium.
Irgens[6]	28	F.	Right occipital and petrous bone.	Inoperable. Treated with radium. Death nine months later.

CASE REPORTS

Case 1.—Referred by Dr. C. V. Edwards, of Council Bluffs, Iowa: D. T., female, age three, had had a normal birth and the rate of development was uneventful. However,

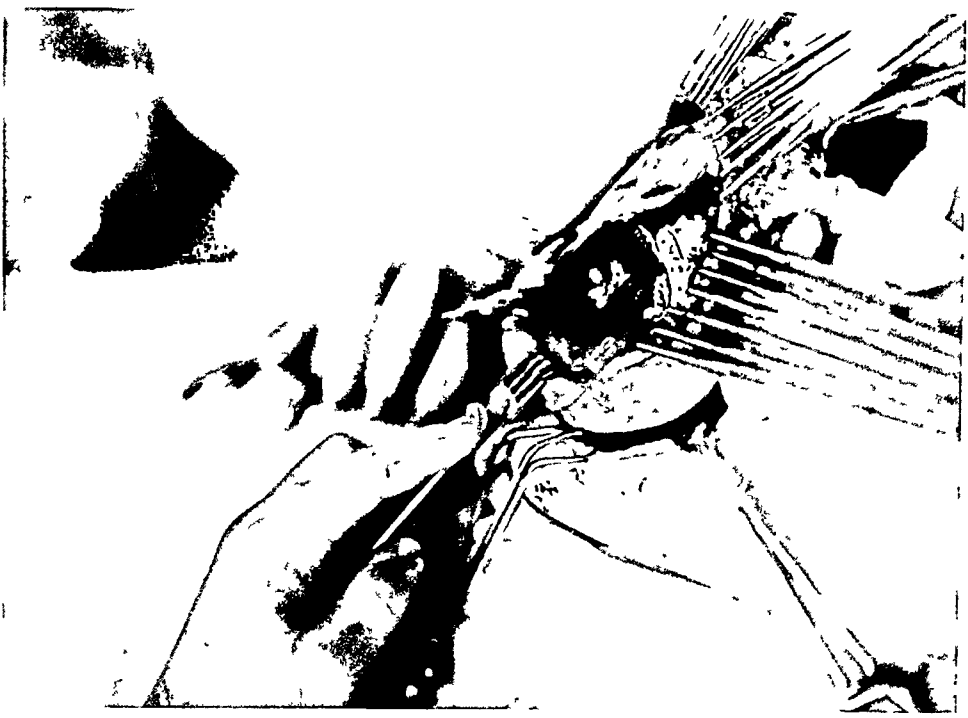


FIG 2.—The angioma exposed at operation.



FIG 3.—Illustrates the intact inner table of skull after removal of the angioma.

from birth it was noted that there was a defect in the right frontal region which would become larger when the child was reclining and smaller when it was in an upright position. The baby had a tendency to cry out sharply during the night. When two years

of age, roentgenograms were taken, and it was felt that the child was suffering from an encephalocele. Examination, June 23, 1936, revealed a well-developed and well-nourished child, 39½ inches tall, weighing 35 pounds. There was a bulging area in the right frontal region and palpation of this mass revealed the content to be filled with fluid. Auscultation failed to elicit any bruit. When the child would recline the mass would become larger and upon assuming the upright position it would become somewhat smaller. Other than the presence of large, cryptic tonsils, examination was essentially negative, as were laboratory tests of the blood and urine. Wassermann negative. Roentgenograms revealed a bulging mass in the right frontal region with a small line in the skull which might suggest an encephalocele. However, it was lateral to the midline.



FIG. 4.—Photomicrograph of the tissue removed showing capillary angioma containing a marked amount of fibrous stroma. (×100)

The child was admitted to the Neurosurgical Service of Mercy Hospital and an attempt was made to reduce the size of the mass by spinal drainage. However, the spinal fluid pressure was 8 cm. of water, and withdrawal of 30 cc. of cerebrospinal fluid failed to affect the size of the mass. On June 26, 1936, under avertin anesthesia, a needle was introduced into the mass and bloody fluid was aspirated. A hockey-stick incision was then made around the mass, which was the size of a large frankfurter, measuring 10x4 cm. The skin was dissected away and a tumor mass was found to be attached to the skull. The mass was covered with periosteum.

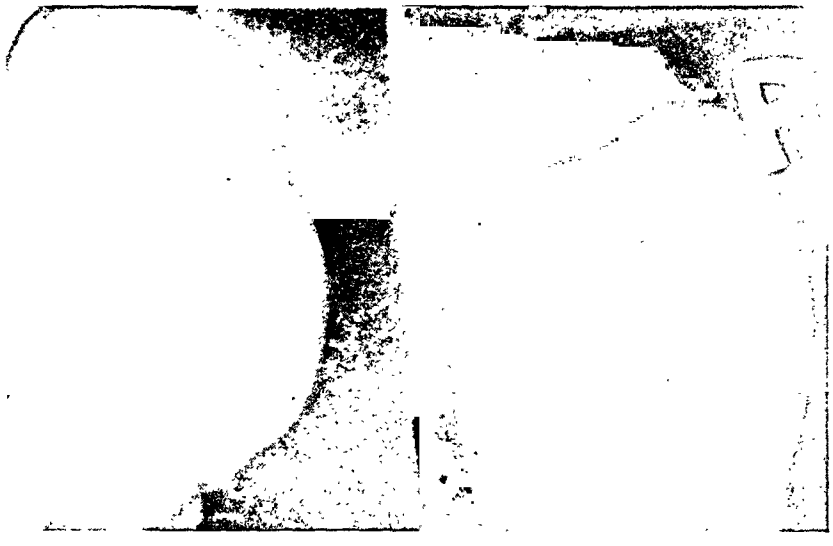


FIG. 5.—Roentgenograms showing a bulging, soft tissue mass in the right parietal region.

On carefully dissecting this mass free, many small veins were seen which communicated with the mass on the inner table of the skull which was found to be intact. The mass had completely replaced the outer layer of the skull. After its removal the bleeding of the bone was controlled with bone wax and an opening made in the inner table of the skull failed to reveal tumor tissue below.

Recovery was uneventful, and the child was dismissed from the hospital in ten days. Pathologic examination of the tumor showed it to be a capillary angioma of the skull.

A letter from the child's parents, February 26, 1937, stated that the little patient was developing normally and that there was no evidence of recurrence of the tumor.



FIG. 6.—The angioma exposed at operation

Case 2.—Referred by Dr. Keith Chapler of Dexter, Iowa. W G, male, age three weeks. The baby had been delivered in a normal manner but it was found that there was a large mass involving the entire right parietal region The mass did not increase nor decrease in size during a period of three weeks' observation and, because of the same character of the tumor, it was felt that the child was not suffering from an hematoma of the skull Examination revealed a well-developed and well-nourished baby of three weeks. Weight 8 pounds, 13 ounces. There was a large sausage-shaped mass, measuring 10×3 cm, involving the right parietal bone. Roentgenograms of the skull revealed a typical sunburst appearance of the inner table.

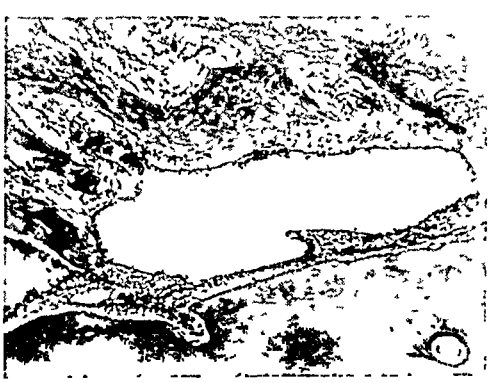


FIG. 7.—Photomicrograph showing a cavernous angioma (×100)

Because of the first case, a preoperative diagnosis of angioma of the skull was made On April 15, 1939, a hockey-stick incision was made around the bulging mass and the scalp was reflected over the tumor There was a bluish tumor, covered with periosteum, which was removed from the skull.

The skull was irregular and there was a typical sunburst appearance of the parietal bone, measuring 3×5 cm, which was removed. Pathologic examination revealed the tumor to be a cavernous angioma.

The child made an uneventful recovery and, when seen September 22, 1939, was developing in a normal manner; there was no evidence of recurrence of the tumor.

CONCLUSIONS

Angioma of the skull is distinguished by the soft compressible tumor mass which sometimes is reduced in size when the patient assumes the erect position and enlarges, to a degree, when in the reclining posture. Roentgenograms reveal a so-called "sunburst" appearance, signified by radiating lines. This is more true in the adult than in children and it is my opinion that these may be removed surgically if extreme care is used in the control of hemorrhage during the operation.

BIBLIOGRAPHY

[1] Christensen, F. C.: Bone Tumors: Analysis of 1,000 Cases, with Special Reference to Location, Age and Sex. ANNALS OF SURGERY, 81, 1074–1092, June, 1925.

[2] Geschickter, C. F., and Copeland, M. M.: Tumors of Bone. Am. Jour. of Cancer, 1931.

[3] Abbott, W. D.: Angioma of the Skull. ANNALS OF SURGERY, 106, 1100–1105, 1937.

[4] Toynbee, J.: An Account of Two Vascular Tumors Developed in Substance of Bone. Lancet, 2, 676, 1845.

Idem: Aneurysm by Anastomosis in the Substance or Parietal Bone. Lancet, 1, 230, 1847.

[5] Anspach, W. E.: Hemangioma of the Bone. J.A.M.A., 108, 617–620, February 20, 1937.

[6] Irgens, E. R.: Hemangioma of Skull Involving Right Petrous and Occipital Bones. Archiv. Otolaryng., 29, 709–712, April, 1939.

[7] Ehrmann: Mus de la fac. de med. de Strasburg. No. 3, 1, 1847. Cited by Schöne.[15]

[8] Cruveilhier, Jean: Anatomie pathologique du corps humain. J. B. Baillere & Fils, Paris, pp. 1, 2, 3, 1856–1862.

[9] von Rokitanski, C.: Lehrbuch der pathologischen Anatomie. 3rd ed., Bd. 11, W. Braumüller, Wien, p. 130, 1856.

[10] Morris, Henry: Pathologic Soc. of London. Brit. Med. Jour., 1, 402–403, March 13, 1890.

[11] Stamm, Carl: Beitrag zur Lehre von den Blutgefässgreschwülsten. W. F. Kaestner, Göttingen, 1891. Cited by von Falkowski, A.: Beitr. z. path. Anat. u. z. allg. Path., 57, 385–414, 1913–1914.

[12] Pilcher, L. S.: Venous Tumor of the Diploe. Trans. Amer. Surg. Assn., 12, 283–285, 1894.

[13] Ziegler, E.: Lehrbuch der allg. path. Anat. Jena, p. 424, 1901.

[14] Zajaczkowski, A.: Ein Fall von Angioma cavernosum des Stirdbeins. Przeglad chir. Bd. IV, Hft. 3; Abst. in Zentralbl. f. Chir., 28, 507–59, 1901.

[15] Schöne, G.: Über einen Fall von myelogenen Hämangiom des Os Occipitale. Beit. z. path. Anat. u. z. Allg. Path., 7, Suppl. 685–701, 1905.

[16] Major, R. H., and Black, D. R.: Hemangioma of the Liver Associated with Hemangiomata of the Skull and Bilateral Cystic Adrenals. Am. Jour. Med. Sci., 156, 469–482, October, 1918.

[17] Brandt, R.: Zur Frage der Angiomatosis retinae. Arch. f. Ophta., 106, 127–165, 1921.

[18] Kaufman, E.: Lehrbuch der spezieller pathologischen Anatomie für Studierende und Aertze. Walter de Gruyter & Co., Leipzig, p. 937, 1922.

[19] Cushing, H.: Surgical End-Results in General, with a Case of Cavernous Hemangioma of the Skull in Particular. Surg., Gynec., and Obstet., 36, 303–308, March, 1923.

[20] Lanari, E. L., and Marque, A.: Angioma of the Diploe. Revista Soc. Arg. de Radioz. El., 1, 47–75, December, 1925; abstr. J.A.M.A., 87, 286, July 24, 1936.

[21] Frös, G.: Multiples Hämangioma der Schädelknochen. Zentralbl. f. allg. Path. u. Anat., 43, 532–538, 1928.

[22] Overend, T. D.: Hemangioma of Occipital Bone. Brit. Jour. Radiol., 6, 626–627, October, 1928.

RESULTS OF SILK TECHNIC IN OPERATIONS FOR HERNIA*

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SILK SUTURE material in the surgical repair of hernia is not new. As long ago as 1890, Bassini used silk in his repairs but, in 1892, discarded it in favor of chromic catgut because of his infection rate and sinus formation. In 1899, W. B. Coley recorded his objection to the use of silk. He reported 400 operations upon children, with six recurrences—three with the Bassini method and three with other methods. There were three deaths; and he states primary union occurred in 373, slight suppuration in 15, and considerable in nine. There were two silk technic cases in his series; one of which resulted in marked suppuration, with extrusion of the sutures, and in the second case primary union occurred but a sinus developed later. Both cases recurred in four months. As a result, Doctor Coley stated he was opposed to nonabsorbable sutures.

Had it not been for the enthusiasm of Halsted and his followers, the use of silk might possibly have been completely discarded. In spite of its general lack of popularity at that time, Halsted continued to use silk; and in recent years there has been a general revival of its use.

Silk has a definite advantage over absorbable suture material in that the sutures remain in place until the wound has completely healed. The use of silk presupposes meticulous care in the handling of the tissues, the use of fine suture material, careful ligation of bleeding points without including great masses of tissue along with the vessels, and by using fine suture material the structures must be approximated without tension. All these factors, absolutely necessary in using silk, are, in themselves, of the utmost importance if primary union is to be obtained. Unless all these necessary precautions are carried out, wound infections and sinuses are likely to result.

In October, 1934, silk as a suture material was begun on the First Surgical Division at the Ruptured and Crippled Hospital, Dr. Carl G. Burdick, Director. At first, only the occasional case was operated upon with silk technic, but as time went on it was employed on more and more of the hernia cases until at the present time only rarely is any other material used.

From October, 1934, to January 1, 1938, 777 hernia operations have been performed on the First Surgical Division at the Ruptured and Crippled Hospital. All operations have been performed by a group of six visiting surgeons and 12 house surgeons.

* Read before the Clinical Meeting of the New York Surgical Society, March 22, 1939. Submitted for publication May 23, 1939.

Before proceeding to a follow-up on these cases, it might be interesting to mention the follow-up results on previously reported series of cases.

Roux reported 54 recurrences in 324 cases traced longer than two years, or a 15 per cent recurrence rate.

Bassini: Seven relapses in 251 cases, or 2.7 per cent.

Halsted: Twelve relapses in 221 cases, or 5.4 per cent.

Kocher: Fifteen relapses in 171 cases, or 8.7 per cent.

Coley: Five relapses in 514 cases (one to seven years), or 0.9 per cent.

Bloodgood, in 1900, reported 394 operations for inguinal hernia at the Johns Hopkins Hospital; 238 of these, personally examined by Doctor Bloodgood, showed six recurrences.

Hoguet, in 1918, reported 3,725 cases of simple inguinal hernia with 14 relapses, or 0.39 per cent.

In 1919, Masson, of the Mayo Clinic, reported 7,016 inguinal herniae repaired with 20-day chromic catgut with less than 1 per cent recurrence.

In 1935, from New York Hospital, Glenn and McBride reported 500 herniae repaired with silk technic with 2.3 per cent recurrence in indirect inguinal group, and 6.21 per cent in the direct inguinal group.

In February, 1939, Longacre, reporting from Presbyterian Hospital, found a 5.5 per cent recurrence rate in all indirect inguinal herniae, with 9.8 per cent recurrence rate in chromic gut cases, and 2.16 per cent in the silk technic cases. In the direct inguinal cases a total recurrence rate of 6.4 per cent with a 13.6 per cent rate in the chromic cases, and 4.49 per cent in the silk technic cases.

In most of the above reports the details of the follow-up are not mentioned. In our series, only those cases seen, and personally examined, at least one year after operation are included. It is our feeling that differences in follow-up methods account for the wide variations in the recurrence rate of the above mentioned series of cases, as the type of operation, except for slight modifications, was essentially the same in each series.

Table I summarizes the results of the 777 operations performed on the First Surgical Service of the Ruptured and Crippled Hospital from October 24, 1934, to January 1, 1938.

TABLE I

Cases Followed One Year or More: 552, or 71 Per Cent.

Primary indirect hernia: 334, with 22 recurrences, or 6.3%
Primary direct hernia: 118, with 15 recurrences, or 12.7%
Primary ventral hernia: 22, with 1 recurrence, or 4.5%
Recurrent inguinal hernia: 40, with 15 recurrences, or 37.5%
Recurrent ventral hernia: 7, with 1 recurrence, or 14.5%
Primary femoral hernia: 20, with 3 recurrences, or 15.0%
Recurrent femoral hernia: 1, no recurrence.

It is interesting to note the infection rate on these cases. We have

classified as infections, every stitch abscess, hematoma, and sinus formation, as well as the deep abscesses—whether or not they prolonged the patient's stay in the hospital. During the first year, from October, 1934, to October, 1935, 85 operations were performed, with three infections, or 3.8 per cent. In the second year (October, 1935, to October, 1936), there were 328 operations, with 11 infections, or 3.3 per cent. In the third year, from October, 1936, to January 1, 1938, there were 364 operations, with five infections, or 1.3 per cent. From January 1, 1938, to January 1, 1939, 614 operations were performed throughout the whole hospital (both service and private cases), with four infections, or 0.65 per cent. This gradual reduction in the infection rate we ascribe, to a great extent, to increasing familiarity with the silk technic.

DISCUSSION: DR. FRANK L. MELENEY (New York) said that the use of silk had come into Presbyterian Hospital from Johns Hopkins in a roundabout way through Peking, China. Adrian Taylor, one of Doctor Halsted's assistant residents, took it over to Peking in 1920, and Doctor Meleney brought it back in 1925. It took four years for him to persuade the Presbyterian staff to use silk in clean cases. This was accomplished in 1930, by a clear demonstration of the very decided difference in the incidence of wound infection between cases sutured with silk and those sutured with catgut. This fact was first demonstrated in a series of thyroid cases, where there had previously been an incidence of infection around 15 to 20 per cent. This encouraged the staff to use silk in a group of herniae and, in 1931, the same unimpeachable evidence proved the superiority of silk over catgut. In 1932, the fracture service took it up, and since then the use of silk has spread to practically all of the clean cases. Since 1925, wound infections and hematomata have been rigidly kept track of, and with any group of cases, every year since 1930, the silk cases have had a lower incidence of both of these complications than the catgut cases. Longacre's recent statistics from Presbyterian Hospital now show that hernial recurrence is also less in silk cases. Of course, there have been individual cases in which silk ligatures have come out of persistent sinuses, but in spite of that the staff at Presbyterian Hospital has become converted to the silk technic because all of the statistics prove it the best, beyond the shadow of a doubt. Doctor Meleney said he had often wondered why Halsted never supported his preference for silk over catgut by comparable statistics. Doctor Heuer has explained this by stating that they had no catgut cases to compare. It is interesting and significant that now reliable statistics are coming from several different clinics which fully support Halsted's clinical observations.

REFERENCE

Meleney, Frank L.: Infection in Clean Operative Wounds. A Nine-Year Study. Surg., Gynec. and Obstet., 60, 264–276, 1935.

MEMOIR

HOMER GAGE

1861–1938

THE CAREER of Homer Gage was the natural and well-nigh inevitable result of the ancestral traits which he inherited from forebears whose intelligence, enterprise, frugality, public spirit and love of liberty contributed to the evolution of the Massachusetts Bay Colony into the New England of to-day.



HOMER GAGE, M.D.

His earliest colonial ancestor settled in Ipswich, Mass., in 1633, and was the progenitor of substantial citizens who fought in the Indian and Revolutionary Wars. The first physician in direct line was his grandfather, Dr. Leander Gage; his father, Dr. Thomas H. Gage, a noteworthy physician of his day, became president of the Massachusetts Medical Society.

Homer Gage was born in Worcester, Mass., October 18, 1861, and died July 3, 1938, at the age of 77, having spent his long life in fruitful activities of the most varied nature in the service of the community of his birth. From the Worcester High School he entered Harvard, graduating from the college with high honors in 1882, and from the Medical School in 1887, and then secured clinical training as surgical house officer at the Massachusetts General Hospital, and at the Children's and Lying-In Hospitals. Though his abilities must have tempted him to settle in the larger metropolis near academic shades, he chose to return to Worcester where he entered general practice in 1888 and speedily began to devote himself to surgery whose attractions were being rendered irresistible by the tardy universal acceptance and adoption of the principles of asepsis and antisepsis. He served the three principal hospitals of Worcester—the City, the Memorial and St. Vincent's—in almost every capacity: surgical, consulting and fiduciary. He knew the satisfactions and felt the obligations of organized medicine, serving as councilor of the Massachusetts Medical Society for 48 years, and as chairman of important committees. It is needless to enumerate the national and local organizations to which he belonged, in most of which his unusual abilities brought offices and honors.

Doctor Gage was elected to Fellowship in the American Surgical Association in 1910, and served as vice-president in 1919. He presented four papers before the association: In 1915, on "Acute Appendicitis as a Complication of Typhoid Fever"; in 1919, on "Postinfluenzal Abscess in the Sheath of the Rectus Muscle"; in 1921, on "End-results of 100 Cases of Cancer of the Breast"; and, in 1923, on "Embryoma of the Kidney." He valued his membership highly, as attested by his constant attendance during his active years. During the World War he rendered distinguished service as chief of the Surgical Division at the Base Hospital at Fort Devens from November, 1917 to February, 1919, retiring with the rank of lieutenant colonel.

On the medical stage of Worcester, Doctor Gage was, for years, a dominant and beneficent figure. He was a skillful and conservatively bold surgeon and a widely sought counselor. He felt great personal interest in the constantly increasing group of young men who, as house officers, became his disciples in the three hospitals which he served, and many of whom became his junior colleagues in practice. These men recorded their obligation by saying: "We feel that we have been brought up by him in our professional life. His personal influence, guidance and consultations, his able working out of surgical problems, wise conservatism and technical skill will remain as a lasting inspiration." Some 30 papers in medical periodicals testify to his sense of obligation to contribute to the education of the profession at large by communicating what he had learned in clinical practice.

During his mature and later years his versatile qualities and wide interests caused him to be drafted into the service of education, philanthropy and finance. He was a perfect example of that quite rare individual, an able physician with equal competence in the world of business and the social

sciences. He became the trusted president, director or trustee of important financial and philanthropic undertakings almost too numerous to mention. He was an overseer of Harvard University for 12 years. He was president of the Community Chest of Worcester for 17 years and directed the raising of its funds. He was a devoted friend of France and was largely instrumental in raising the large sum needed to build and endow the American Dormitory of the University of Paris—a service which won for him a decoration as Commander of the Legion of Honor. A resolution drawn up by associates said: "His service to his fellowmen was of a caliber that few men equal and none surpass; it is hard to imagine a busier and more useful life; . . . philanthropy was his ruling passion."

A man can scarcely lead such a life without the sympathy of a loyal wife which was the privilege of Doctor Gage. His later years were saddened but not crushed by the loss of an only child, a son, who survived the perils of the World War only to die prematurely without issue.

DAVID CHEEVER, M.D.

SECTIONAL MEETINGS OF THE AMERICAN COLLEGE OF SURGEONS

Dates	City	Headquarters Hotel	Participating States
March 10 11 12	Minneapolis Minnesota	Nicollet	Minnesota, North and South Dakota, Iowa, Nebraska, Montana, Kansas, Wisconsin—Manitoba
March 17 18 19	Pittsburgh Pennsylvania	Wm. Penn	Pennsylvania, Ohio, Virginia, West Virginia, Delaware, Maryland, New Jersey, New York, District of Columbia
March 26 27 28	Salt Lake City	Utah	Oregon, Washington, California, Nevada, Idaho, Wyoming, New Mexico, Arizona, Colorado, Montana, Utah

Hospital conferences will be held in connection with each of these meetings. Fellows of the College, members of the medical profession at large, and persons interested in the institutional care of the sick and injured, are invited to the Sectional Meetings; on the final evening of each meeting, a Meeting on Health Conservation to which the public is invited, will be held.

BOOK REVIEWS

ORTHOPEDIC OPERATIONS. By ARTHUR STEINDLER, M.D., Professor of Orthopedic Surgery, University of Iowa. Springfield, Ill.: Charles C. Thomas Co., 1940.

THIS WORK is based upon the author's personal experience, which seems to the reviewer to be a unique asset rather than a liability, as the author fears. Few will take exception to his claim that personal conviction, backed both by reflection and by experience, is the mainspring of unbiased teaching.

The object has been to combine into a triad the indications, technic, and his end-results in the several phases of operative orthopedic treatment. This statement of a modest man does not, however, indicate the scope of the work, for it is far more than a manual of orthopedic technic. Thus, under indications, in Chapter I, he discusses the biology of functional restoration under two headings: (a) Form and alignment; and (b) function—but he again divides the subject of form and alignment into two subtitles: (a) Functional adaptation of bone; and (b) functional adaptation of the soft tissues—the nature of contracture. Under function, he considers four subjects: (1) The relation between stability and mobility; (2) active stability; (3) passive stability, which is subdivided into (a) bone and (b) soft tissues, and (c) joints; and (4) the principles of operative reconstruction of muscle balance.

Chapter II is devoted to special surgical risks in orthopedic operations, and it is divided into three parts with 13 subdivisions.

There are 26 chapters in all, with text prepared with meticulous care, and to this is added an author's index and 22 pages of a subject index.

The publishers have fully attained, in this volume, their desire "to present books that are satisfactory as to their physical properties and artistic possibilities." The binding, paper, type and the illustrations are worthy of the unusual text.

The originality of the arrangement of the subject matter, however, was confusing to

the reviewer, even though he followed the warning of the author that if the book is to be used for reference the reader should first consult Part III for the discussion of the diagnosis, then Part II, for a description of the technic of the contemplated operative procedure, and, finally, Part I, in order to obtain an estimate of the surgical hazards involved and to try to anticipate them, or to treat them if they cannot be prevented. This may be the logical way to prepare and to use a book, but it certainly is not the usual way.

WALTER ESTELL LEE, M.D.

CANCER—A MANUAL FOR PRACTITIONERS. Boston: Committee of the Massachusetts Medical Society, 1940.

THIS BOOK was prepared for the practitioners of medicine in Massachusetts by a special committee of the State Medical Society, and financed jointly by the United States Public Health Service and the Massachusetts Branch of the American Society for the Control of Cancer.

It is indeed a fitting legacy from the men to whom it is dedicated:

Robert B. Greenough, M.D., surgeon, whose work to further our knowledge of malignant disease, and to control its ravages through education and modern methods of treatment, places him among the leaders of his generation in this field.

George H. Bigelow, M.D., who, as former Massachusetts Commissioner of Public Health, instituted the plan for cancer control, now in successful operation in that State, and which, in principle, is being generally adopted in other communities.

In the 44 chapters the reader will find a presentation of this problem which we feel would have met with the approval of these two surgeons.

The early chapters, which deal with such general subjects as the historic trend, epidemiologic aspects and principles of treatment, serve as a prologue to the 27 chapters dealing with the special tissues and organs. The closing chapters are concerned with such subjects as leukemia, Hodgkin's disease, industrial cancer, tumors of the endocrine glands, and the care of the patient with advanced cancer.

It will thus be seen that it is all inclusive and should be of incalculable value, not only to the rank and file of the medical profession for whom it was prepared, but also to the specialist as a reference book.

The discussion of the historic trends, by Eleanor MacDonald, makes fascinating reading and presents evidence that the problem of cancer has staggered and intrigued man from the beginning to the present time. She refers to an ancient Indian epic, the Ramayana, of about 2000 B.C., in which a disease was described that was evidently cancer. At that early date, the Indians were the first group to leave records of a systematic presentation of disease. Though their knowledge of anatomy was quite superficial, their surgery was daring, and radical extirpation of malignancy was practiced. It was the Egyptians who introduced arsenic in the form of a paste for the removal of malignancy, and the term cancer was first used by Hippocrates, but with the meaning of "benign tumor," while he employed the word "carcinoma" to describe malignant tissue.

Murphy, in his description of the trend in cancer research, concludes his article with the statement that the fundamental problem in the search for the genesis of cancer is the understanding of the factors responsible for the growth property of the cancer cell. In order to reduce this question to an experimental level, he assumes, with some evidence, that there is in the cell an interacting, balancing mechanism regulating growth and differentiation, and that malignancy represents a break in this mechanism.

Daland, in the chapter on "Cancer of the Breast," offers a statistical report from the Pondville Hospital, which deserves widespread publicity to the lay public as well as to the medical profession because of their encouraging results.

Sixty-nine per cent of their patients have shown five-year cures when the axillary nodes have not been involved. When this same group was followed from five to 11 years,

the percentage dropped only to 64 per cent. Thirty-two per cent of the cases were apparently well after five years in the group in which the malignancy extended beyond the breast at the time of the operation; there was a fall to 30 per cent only when these patients were followed from the fifth to the eleventh years. The combined percentage of recovery in these two groups, of 45 per cent after five to 11 years, is indeed surprising.

Pemberton does not offer such encouraging results in his chapter on cancer of the ovaries, and although there is an expectant salvage of 35 per cent after five years post-operatively, only 11 per cent of these patients are free of the disease. The results are discouraging and earlier diagnosis must be made if we are to obtain any improvement.

Space will not permit a more detailed discussion of this compilation of our present knowledge of the subject of cancer, but we hope that this review will convince the medical profession that the report contains reference material from an authoritative source which should be in the library of every physician and surgeon.

WALTER ESTELL LEE, M.D.

BOOKS RECEIVED

THE SURGERY OF THE ALIMENTARY TRACT. By Sir Hugh Devine, M.S., F.R.A.C.S., F.A.C.S., Baltimore: Williams and Wilkins Co., 1940.

BIOLOGICAL SYMPOSIA. VOL. I. Edited by Jaques Cattell, Lancaster, Pa.: Jaques Cattell Press, 1940.

SYNOPSIS OF PRINCIPLES OF SURGERY. By Jacob K. Berman, M.D. St. Louis: C. V. Mosby Co., 1940.

THE ANATOMY OF THE FEMALE PELVIS. By F. A. Maguire, C.M.G., D.S.O., V.B., M.D., Ch.M., F.R.C.S. (Eng.), F.R.A.C.S., F.R.C.O.G., 3rd Ed., Sydney and London: Angus and Robertson, 1940.

THE 1940 YEAR BOOK OF RADIOLOGY. Edited by Charles A. Waters, M.D., Whitmor B. Firor, M.D., and Ira I. Kaplan, B.Sc., M.D., Chicago: The Year Book Publishers, 1940.

HANDBOOK OF HEARING AIDS. By A. F. Niemoeller, M.A., New York: Harvest House, 1940.

COMPLETE GUIDE FOR THE DEAFENED. By A. F. Niemoeller, M.A., New York: Harvest House, 1940.

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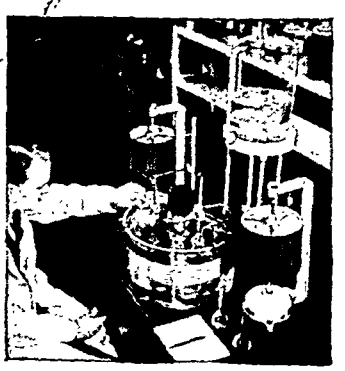
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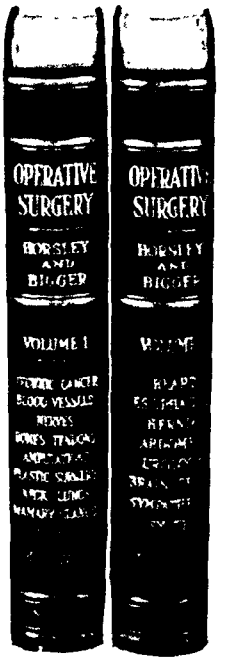
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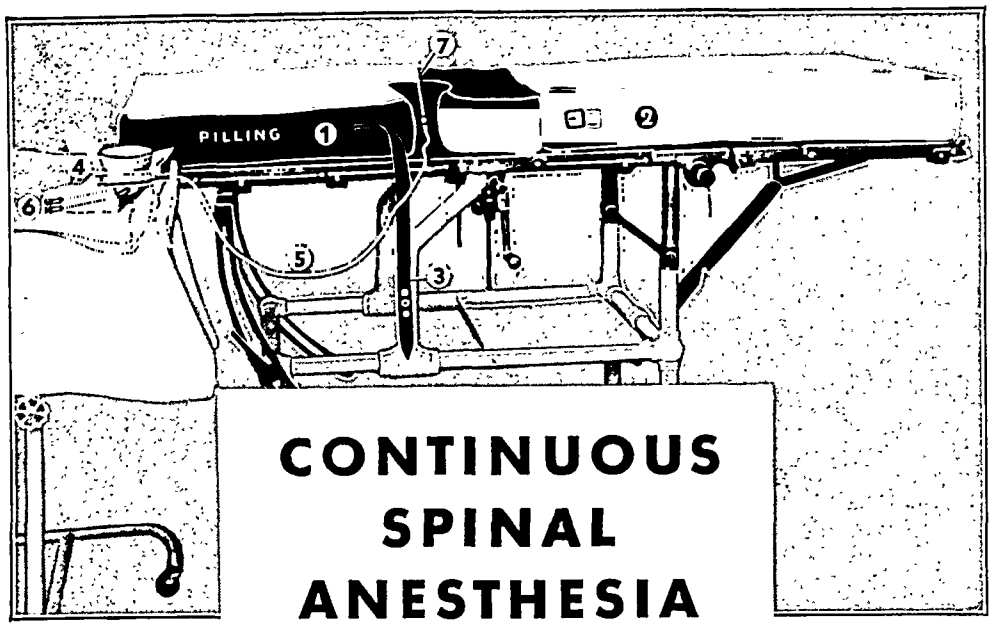
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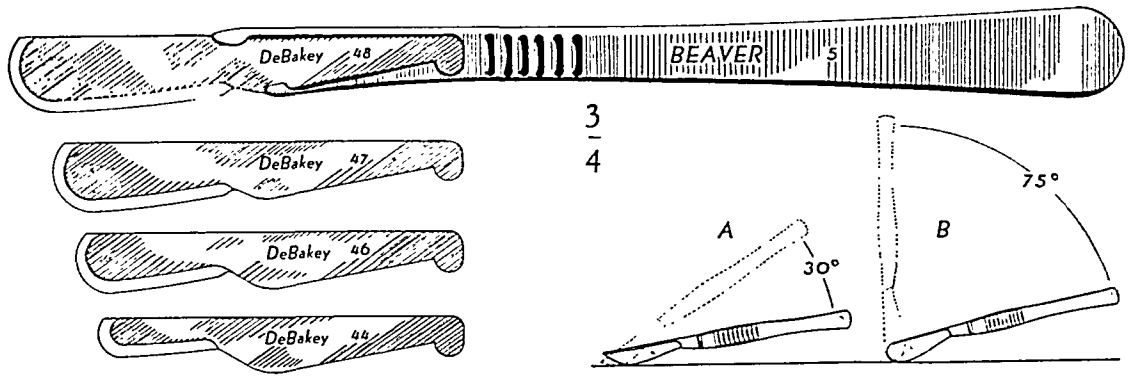
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CONTENTS

Vol. 113 MARCH, 1941 No. 3

CANCER OF THE BREAST..... Carl Eggers, M.D.
Tibor de Cholnoky, M.D.
D. S. D. Jessup, M.D.
New York, N. Y. 321

NIPPLE DISCHARGE..... Paul R. Hinchey, M.D.
Salem, Mass. 341

SURGICAL TREATMENT OF TUMORS OF THE MEDIASTINUM..... George J. Heuer, M.D.
New York, N. Y. 357

HETEROTOPIC PANCREATIC TISSUE PRODUCING PYLORIC OBSTRUCTION..... Earl G. Krieg, M.D.
Detroit, Mich. 364

ILEOJEJUNITIS..... Burrrill B. Crohn, M.D.
Albert M. Yunich, M.D.
New York, N. Y. 371

NEPHRO-OMENTOPEXY AND NEPHROMYOPEXY IN THE TREATMENT OF ARTERIAL HYPERTENSION..... Maurice Bruger, M.D.
R. Franklin Carter, M.D.
New York, N. Y. 381

MALIGNANT MELANOMA..... Tibor de Cholnoky, M.D.
New York, N. Y. 392

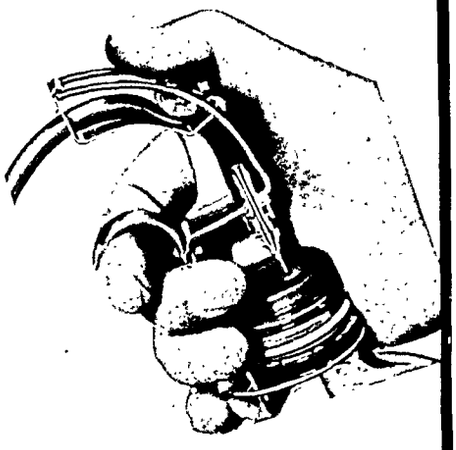
SMOKING AND THROMBO-ANGIITIS OBLITERANS Frank V. Theis, M.D.
M. R. Freeland, M.D.
Chicago, Ill. 411

(Contents continued on page 4)

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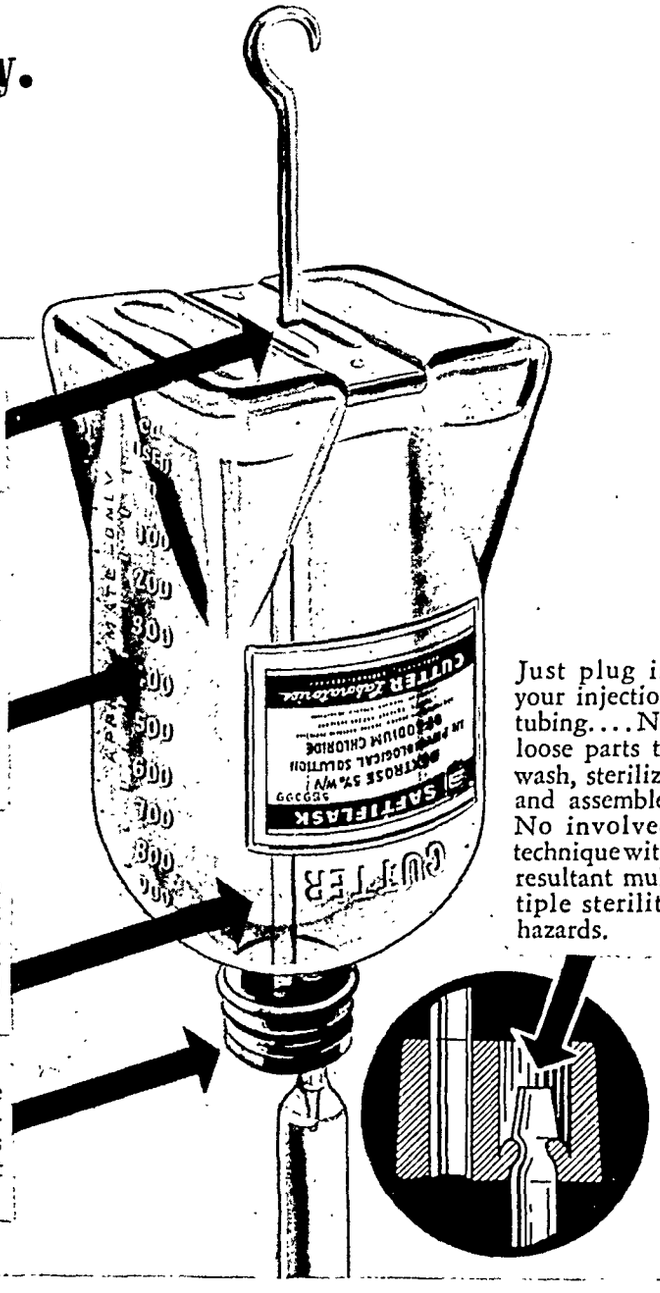
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CONTENTS—*Continued*

THE RATE OF HEALING OF TENDONS..... Michael L. Mason, M.D.
Harvey S. Allen, M.D.
Chicago, Ill. 424

PARTIAL MYOTOMY IN THE TREATMENT OF DIVIDED FLEXOR TENDONS OF THE HAND.. Lester Blum, M.D.
New York, N. Y. 460

DISLOCATION OF THE FIRST CERVICAL VERTEBRA Jesse Thompson Nicholson, M.D.
Philadelphia, Pa. 464

BRIEF COMMUNICATIONS AND CASE REPORT

A MECHANICAL AID FOR VENIPUNCTURE..... Fred F. Rudder, M.D.
Atlanta, Ga. 476

DELAYED HEMORRHAGE FOLLOWING TRAUMATIC RUPTURE OF THE SPLEEN—WITH PARTICULAR REFERENCE TO ROENTGENOLOGIC FINDINGS..... J. Montgomery Deaver, M.D.
Philadelphia, Pa. 477

ERRATUM..... 480

CORRECTION..... 480

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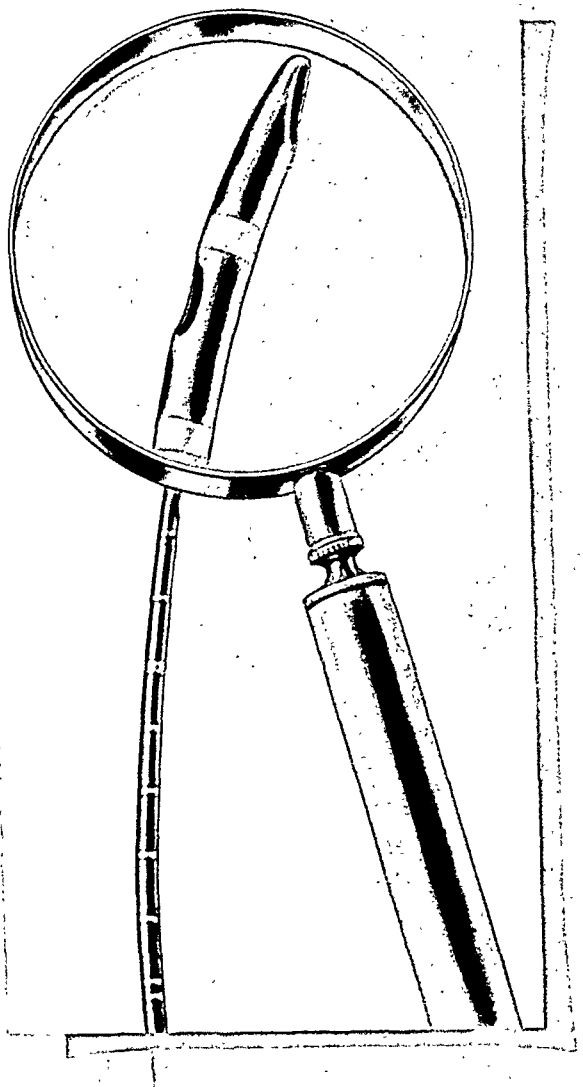
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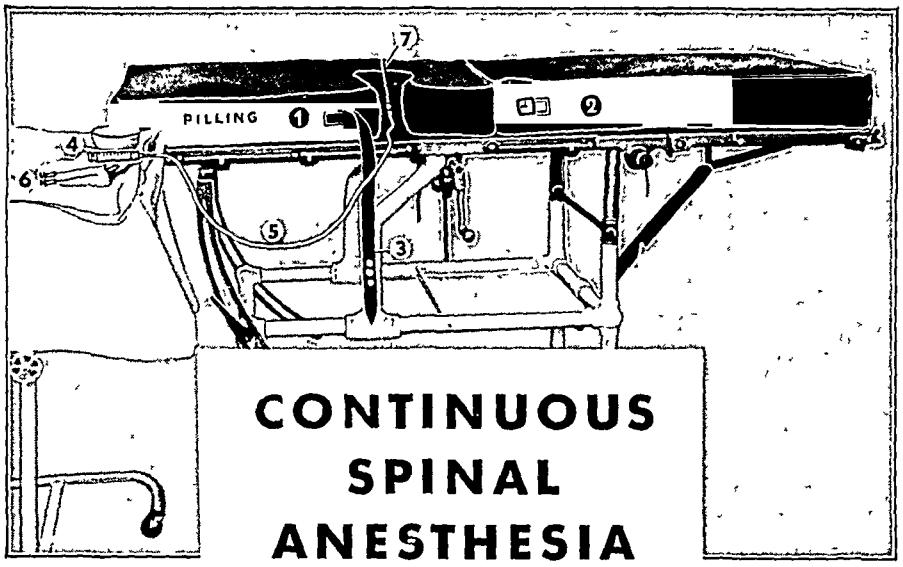
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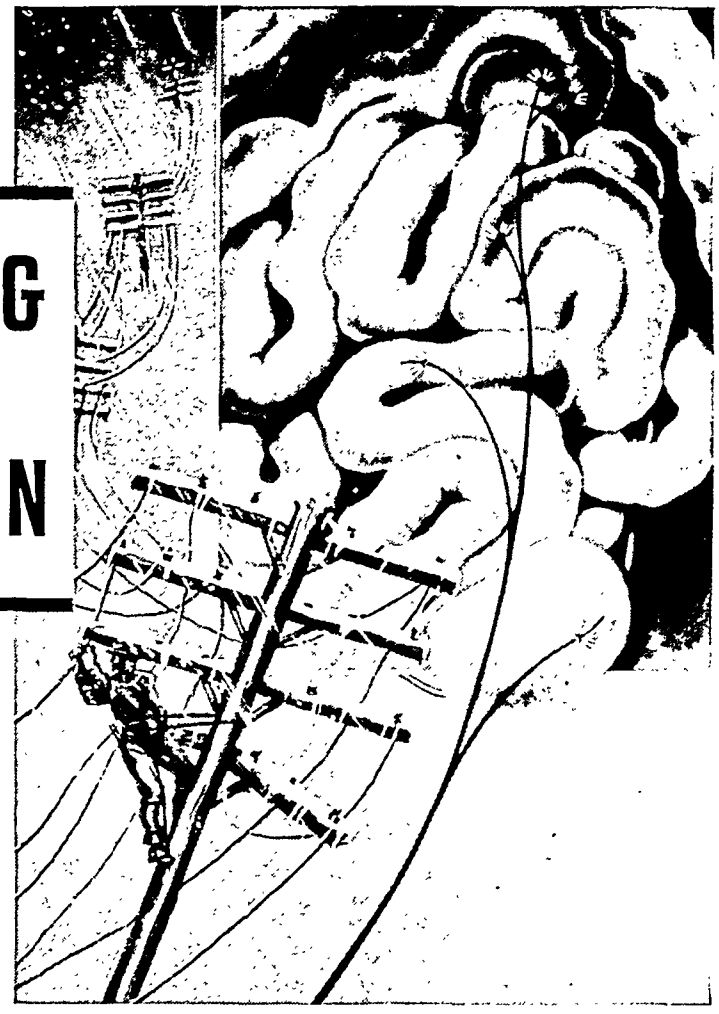
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INDEX TO ADVERTISERS

	Page
SURGICAL SUPPLIES	
American Cystoscope Makers, Inc.	5
Rudolph Beaver	10
Clay-Adams	27
Wilmot Castle Co.	11
Cutter Laboratories	3
V. Mueller & Co.	10
George P. Pilling & Son Co.	6, 22
LIGATURES	
Davis & Geck, Inc.	Insert, 8–9, 16
C. De Witt Lukens Co.	16
Deknatel	20
Johnson & Johnson	15
PHARMACEUTICAL SUPPLIES	
Anglo-French Drug Co., Inc.	Inside Front Cover
Armour & Company	14
Bilhuber-Knoll Corporation	22
Ciba Pharmaceutical Products, Inc.	Back Cover
Coca Cola	20
Duke Laboratories, Inc.	18
Hoffmann-La Roche, Inc.	7
Eli Lilly and Company	12
Merck & Co., Inc.	17
Purdue Frederick Company	18
Schering Corporation	Inside Back Cover
Frederick Stearns and Company	19
Upjohn Company	9
Wander Co., The	13
William R. Warner & Co., Inc.	25
Winthrop Chemical Co., Inc.	8
PUBLISHERS	
Lea & Febiger	24
J. B. Lippincott Company	10, 27, 28
C. V. Mosby Company	26
X-RAY APPARATUS AND SUPPLIES	
General Electric X-ray Corporation	21
Patterson Screen Co.	23
Radium Emanation Corporation	4
SCHOOL	
Harvard Medical School	27

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*PROSTIGMIN METHYLSULFATE 1:4000, 1 cc, boxes of 12 and 100 ampuls, blue label. For the prevention of postoperative distention.

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*Dimethylcarbamic ester of 3-hydroxyphenyltrimethyl-ammonium methylsulfate.

†Dimethylcarbamic ester of 3-hydroxyphenyltrimethyl-ammonium bromide.

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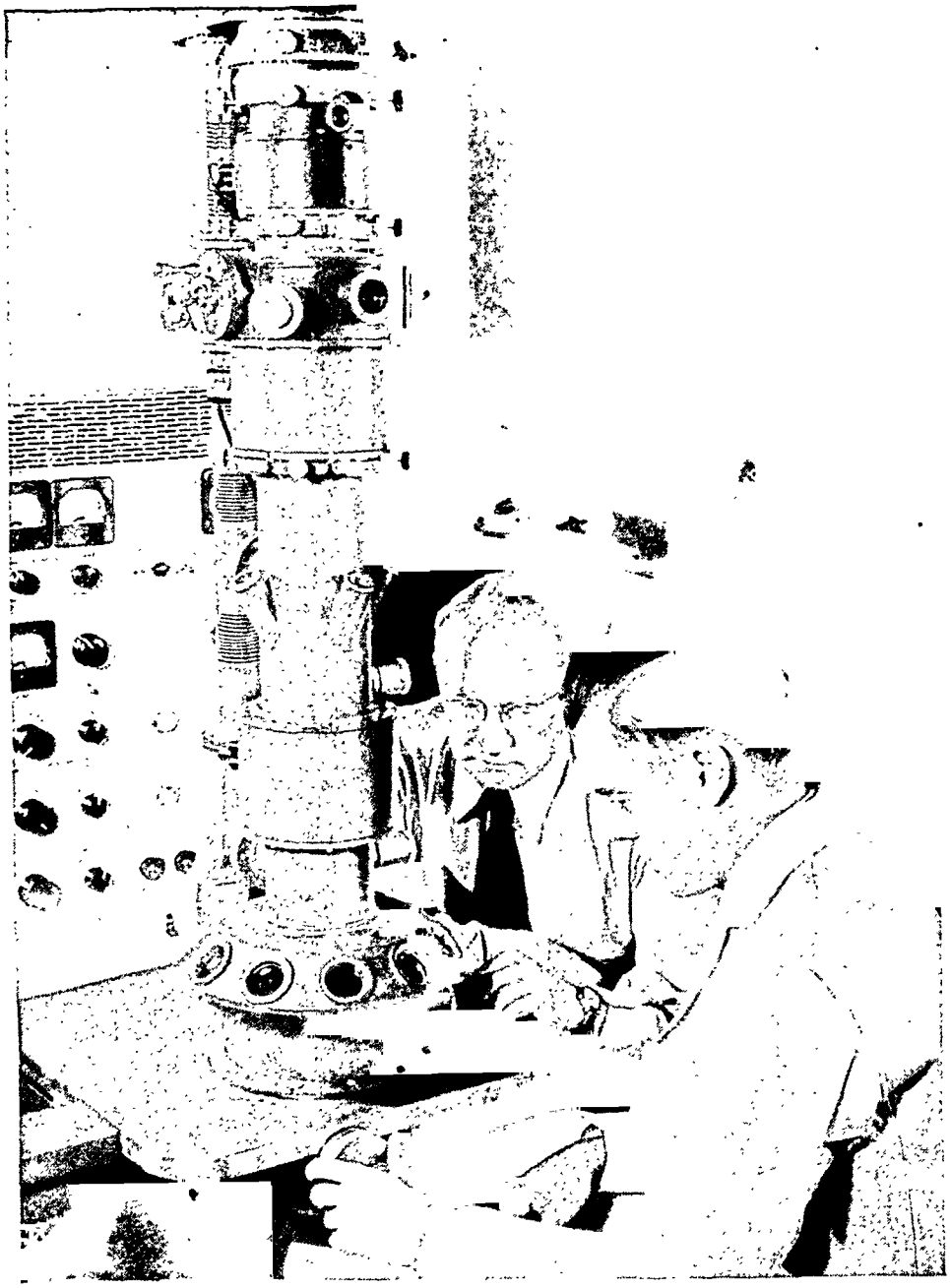
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Acquisition of the first of these new instruments conforms with the DAVIS & GECK policy of providing its research staff with every possible facility.

The potentialities of an instrument which carries vision into the realm of molecules seem limitless. The electron microscope, therefore, constitutes a most important supplement to research equipment already rated among the most complete in this country.

Further details of the Electron Microscope are given on the third page following

DAVIS & GECK, INC., BROOKLYN, NEW YORK

D&G Sutures

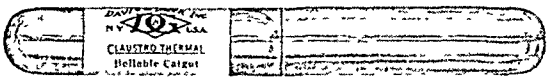
NOTE: In agreement with the new U. S. P. nomenclature, catgut products formerly known as Plain, 10-day, 20-day, and 40-day, are now designated as

Plain – type A — **Medium chromic – type C**

Mild chromic – type B — **Extra chromic – type D**

THERE HAS BEEN NO CHANGE IN THE PRODUCTS THEMSELVES

Claustro-thermal Catgut



POSSESSES all the qualities essential to proper function and is adaptable to all conditions and technics. The tubes may be boiled or autoclaved for asepticization of their outer surface or treated germicidally.

This catgut offers the additional safety factor of CLAUSTRO-THERMAL★ sterilization—an exclusive D&G process wherein heat, at temperatures lethal to the most resistant spores and organisms, is applied AFTER the suture is hermetically sealed in its glass tube and thus fully protected.

NO.		LENGTH *in excess of*	SIZES
1205	Plain—type A	54″	5-0 to 4
1225	Mild chromic—type B	54″	4-0 to 4
1245	Medium " —type C	54″	4-0 to 4
1285	Extra " —type D	54″	4-0 to 4

Package of 12 tubes of a kind $3.60

Thermo-flex Catgut

FLEXIBILITY is the feature of this catgut. Ready for use as it comes from the tubes, it requires no special preparation.

Though of the THERMO-FLEX,★ *non-boilable*, type, there is no compromise in sterility. It is sterilized by HEAT at temperatures exceeding the most rigid bacteriologic requirements.

NO.		LENGTH *in excess of*	SIZES
1405	Plain—type A	54″	5-0 to 4
1425	Mild chromic—type B	54″	4-0 to 4
1445	Medium " —type C	54″	4-0 to 4
1485	Extra " —type D	54″	4-0 to 4

Package of 12 tubes of a kind $3.60

Kal-dermic Sutures

KAL-DERMIC★ represents the culmination of eight years' research to perfect a skin and tension suture combining the best features, while eliminating the disadvantages of silkworm gut, horsehair, silk and several synthetic products variously named.

Kal-dermic is completely stable. It is highly resistant to tissue fluids and germicides; its color is permanent under all conditions; and the strand may be repeatedly boiled or autoclaved without impairment.

KAL-DERMIC SKIN SUTURES

In tubes, sterilized
(Twelve tubes to a box)

NO.	NEEDLE	LENGTH	SIZES	PER BOX
550	None	2 x 60″	4-0 to 0	$3.60
953	3/8-circle	20″	000, 00, 0	3.00
954	Half-curved	20″	000, 00, 0	3.00
852	None	40″	8-0, 6-0, 4-0 to 0	1.80

On reels, unsterilized
(Ten reels to a box)

			NET, PER DOZ. BOXES
50	None	190″	0000 $10.50
			000 11.64
			00 12.60
			0 14.40

KAL-DERMIC TENSION SUTURES

In tubes, sterilized
(Twelve tubes to a box)

				PER BOX
555	None	60″	1 to 4	$3.60
855	None	20″	1, 2, 3	1.80

On reels, unsterilized
(Ten reels to a box)

				NET, PER DOZ. BOXES
55	None	190″	1	$17.40
			2	20.16
			3	22.80

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Heat Sterilized

Fine-gauge Catgut

A CHROMIC suture of exceedingly fine diameter which facilitates accurate apposition and provides prolonged retention with a marked reduction in trauma and virtual absence of reaction.

CLAUSTRO-THERMAL (*boilable*)

NO.	NEEDLE	LENGTH *in excess of*	SIZES	DOZEN
50341	Straight	28″	5-0	$3.60
50344	Half-circle	28″	5-0	4.20
50245	None	54″	5-0	3.60
40341	Straight	28″	4-0	3.60
40344	Half-circle	28″	4-0	4.20
40245	None	54″	4-0	3.60

THERMO-FLEX (*non-boilable*)

50541	Straight	28″	5-0	$3.60
50544	Half-circle	28″	5-0	4.20
50445	None	54″	5-0	3.60
40541	Straight	28″	4-0	3.60
40544	Half-circle	28″	4-0	4.20
40445	None	54″	4-0	3.60

Packages of 12 tubes of a kind and size

Anacap Silk

NEW principles of fabrication provide ANACAP* silk with unprecedented strength, knot security, and absolute non-capillarity.

NO.	LENGTH	SIZES	DOZEN
A40	40″	8-0, 6-0, 4-0 to 4	$1.80
A120	2 x 60″	8-0, 6-0, 4-0 to 4	3.60

Packages of 12 tubes of a kind and size

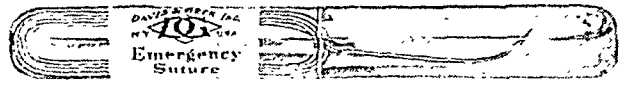
Unabsorbable Sutures

NO.	MATERIAL	LENGTH	SIZES
350	Celluloid-linen	60″	000, 00, 0
360	Horsehair	6 x 28″	00
390	White silkworm gut	6 x 14″	00, 0, 1
400	Black silkworm gut	6 x 14″	00, 0, 1
450	White twisted silk	60″	000 to 3
460	Black twisted silk	60″	000 to 2
480	White braided silk	60″	00, 0, 2, 4

Packages of 12 tubes of a kind $3.60

Emergency Kit Sutures

THREADED on half-curved or 3/8-circle eyed needles with cutting edges for skin, muscle, or tendon. Heat sterilized in glass tubes which may be either boiled or submersed in any active germicidal solution to asepticize their outer surface.



WITH HALF-CURVED NEEDLES

NO.	MATERIAL	LENGTH *in excess of*	SIZES
904	Plain—type A catgut	18″	00 to 3
914	Mild chromic—type B	18″	00 to 3
924	Medium chromic—type C	18″	00 to 3
954	Kal-dermic	20″	000, 00, 0
964	Horsehair	2 x 28″	00
974	White silkworm gut	2 x 14″	00, 0
984	White twisted silk	20″	000, 0, 2
986	Anacap silk	20″	000, 0, 2
900	Assorted: Catgut, Silk, and Kal dermic		



WITH 3/8-CIRCLE NEEDLES

903	Plain—type A catgut	18″	00 to 2
923	Medium chromic—type C	18″	00 to 2
953	Kal-dermic	20″	000, 00, 0
963	Horsehair	2 x 28″	00
973	White silkworm gut	2 x 14″	0
983	White twisted silk	20″	000, 0, 2
985	Anacap silk	20″	000, 0, 2
930	Assorted: Catgut, Silk, and Kal-dermic		

Packages of 12 tubes of a kind $3.00

Other D & G Sutures

IN ADDITION to the foregoing a wide variety of suture-and-needle combinations is available for intestinal, thyroid, tonsil, eye, harelip, cleft palate, plastic, nerve, artery, obstetrical, circumcision, ureteral, renal and dental surgery. A complete list of sizes, lengths, needle combinations, etc. will be supplied on request.

DISCOUNTS ON QUANTITIES

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A New Aid to Suture Research

The Electron Microscope

FOR SOME YEARS it appeared that an impasse had been reached in the extension of microscopic observation. The ability to penetrate smaller and smaller fields depends not upon greater magnification—which is limitless—but upon increased resolving power, or the power of discriminating between minute objects in close proximity. Since resolution is definitely limited to the wave length of the medium of illumination employed, the maximum efficiency of the optical or light microscope was attained when it was adapted to the use of short wave ultra-violet radiation.

Efforts to explore beyond the limits of the microscope, therefore, turned to indirect methods until it was observed that a close analogy exists between the action of a glass lens on a light beam and that of an electro-magnetic field on an electron beam. This suggested the development of an instrument which, in place of light, would utilize electronic emanations of infinitesimal wave length. The outcome was the electron microscope.

IN GENERAL PRINCIPLE and in arrangement of its essential elements this instrument is quite similar to the light microscope. The electron beam is condensed, passed through the specimen, enlarged and focused upon a fluorescent screen for direct observation or upon a photographic plate as desired.

Manipulation of the electron microscope differs from that of the light microscope in that focusing is done by varying the lens power instead of changing the position of the specimen with respect to the lens. This is possible because in magnetic optics "lenses" are created and controlled by current flowing through a coil. Ability to vary the lens power also permits continuous variation of magnifying power —a marked advantage over the step by step method of the light microscope.

THE PERFORMANCE of the present instrument conclusively demonstrates its practicability and great immediate value. It permits direct observation in magnifications up to 30,000 diameters and photographic magnifications up to 100,000 diameters. Moreover, many specimens transparent to light are shown in detail by the electron beam without recourse to staining.

Experiments conducted thus far indicate that the electron microscope opens a way to medical research of profound significance.

DAVIS & GECK, INC.

GONADOGEN*



Another Contribution from the Biochemist to Modern Medical Science

The literature of the past decade offers convincing evidence of the intensive research which has been directed toward the discovery of a product which would faithfully reproduce in humans the gonad-stimulating effects of the anterior pituitary gland.

Since the discovery of the hormone of pregnant mares serum in 1930, its physiologic properties have been exhaustively investigated. These studies, both in animals and in humans, indicate that this hormone does possess gonadotropic effects which closely simulate those of the anterior pituitary gland.

Gonadogen is a highly purified preparation of this hormone. Prepared by the method developed by Cartland and Nelson in the Upjohn Research Laboratories, it is obtained in a high state of purity as a white, water-soluble powder which is stable in the dry form. Substantially free of serum proteins, it may be employed in human patients for subcutaneous, intramuscular or intravenous administration.

Gonadogen opens a new field of therapeutic possibility. Physicians are invited to send for comprehensive literature.

Gonadogen is available, through all pharmacies, in two strengths—in boxes of six rubber-capped vials, each vial containing one sterile tablet of 10 Cartland-Nelson units (approximately 200 International units), together with six 1 cc. ampoules physiologic salt solution; and in boxes of three rubber-capped vials, each vial containing one sterile tablet of 20 Cartland-Nelson units (approximately 400 International units), together with three 1 cc. ampoules physiologic salt solution.

*Trademark Reg. U. S. Pat. Off.



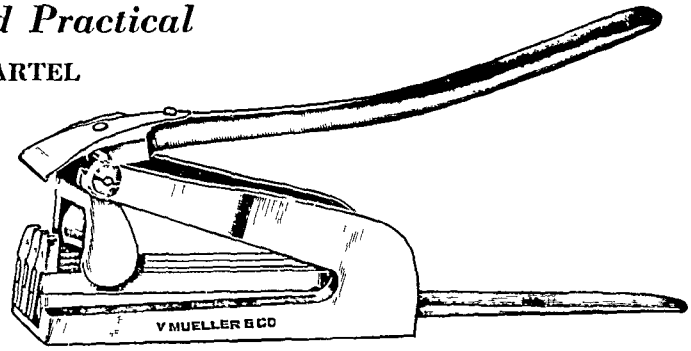
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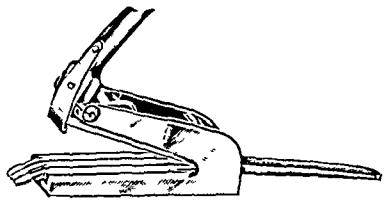
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The three de Martel type blades closed in holder. Below: Blades open, ready for application as a unit.

The Cope Clamp consists of three stainless steel biting blades of the de Martel type, each with end catch to hold it in place. These, inserted as a unit over the bowel, are securely clamped in place with the removable crushing clamp holder.



The Cope Clamp reduces possibilities of soiling, and furthers restorative surgery of the bowel. It enlarges the number of cases in which such surgical treatment can be given, and is a dependable, sure, mechanical aid in deep abdominal work.

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REFERENCE: Surgery, Gynecology & Obstetrics, Feb. 1, 1941, Vol. 72, No. 2, pp 213-221; CANCER OF THE RECTUM AND RECTOSIGMOID, ITS SURGICAL TREATMENT, by Fred W. Rankin, M.D., F.A.C.S

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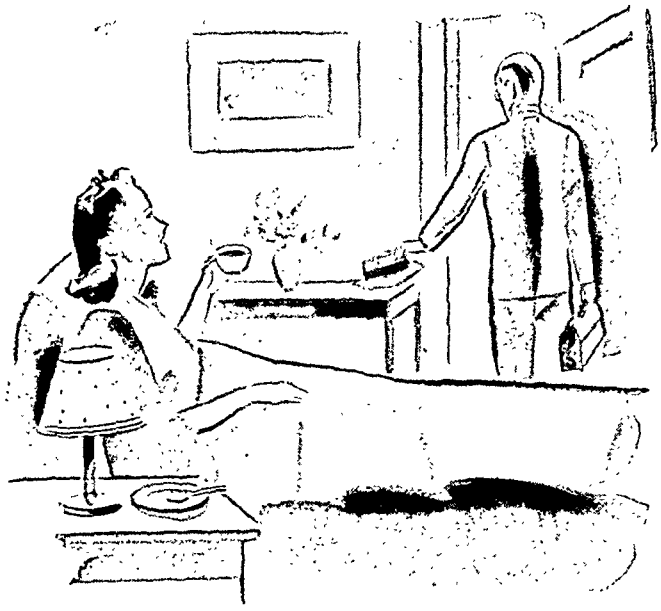


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Preoperatively

FOR A BETTER SURGICAL RISK

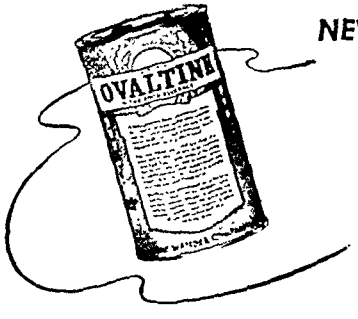
In the many instances when the nutritional state of the patient must be brought to a better level in order to make anesthesia and surgery less hazardous, Ovaltine can be of signal value. Without unduly burdening the digestive apparatus it contributes materially to the protein and carbohydrate intake, and supplies appreciable amounts of needed minerals and vitamins.

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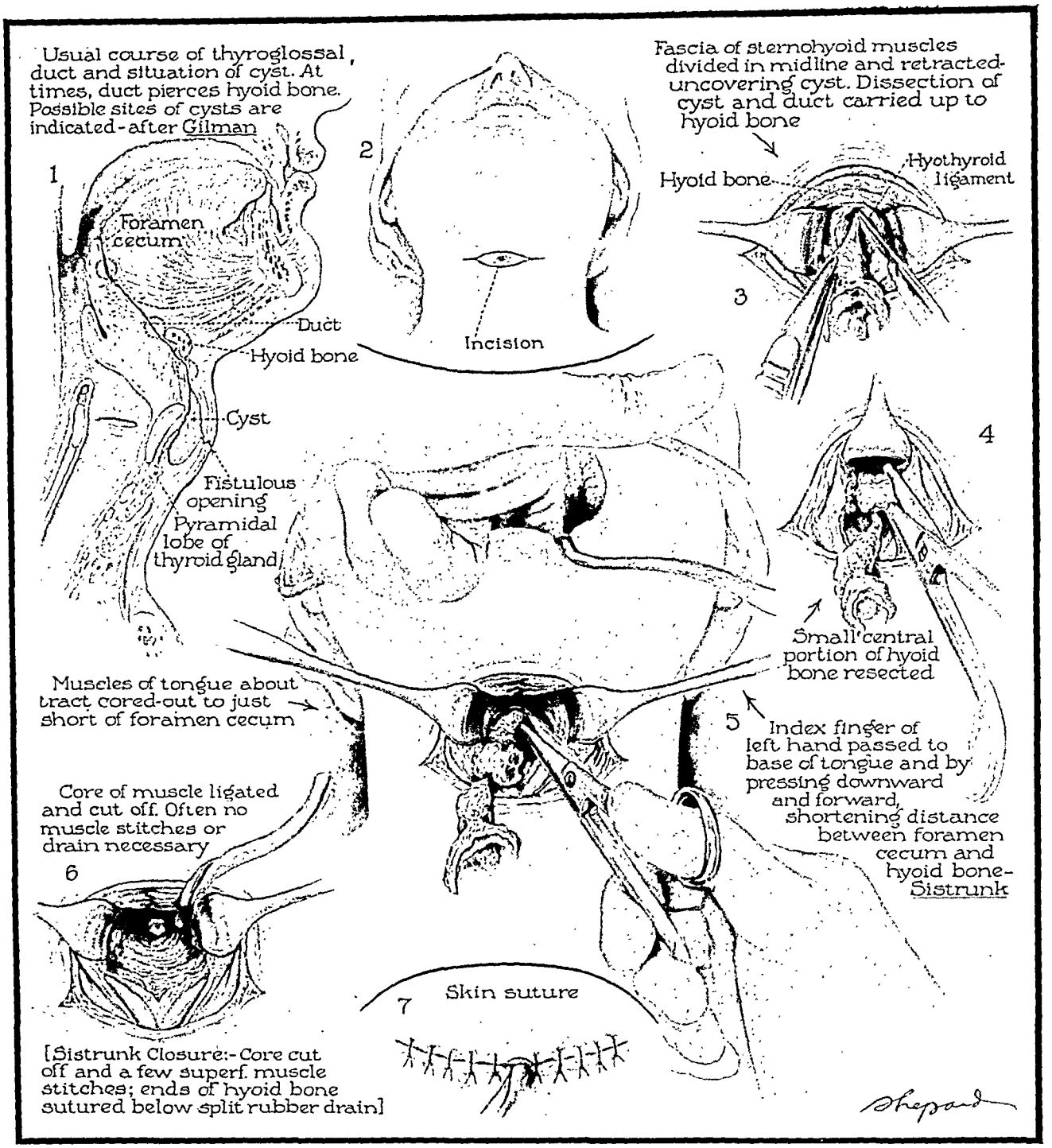
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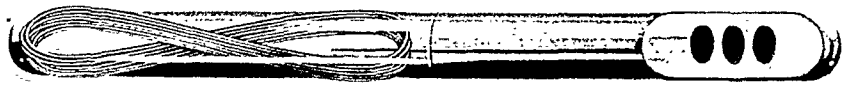
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DAVIS & GECK, INC., BROOKLYN, NEW YORK

ANNALS OF SURGERY

VOL. 113 MARCH, 1941 No. 3

CANCER OF THE BREAST*

CARL EGGERS, M.D.,
TIBOR DE CHOLNOKY, M.D.
AND
D. S. D. JESSUP, M.D.
NEW YORK, N. Y.

FROM THE SURGICAL SERVICE OF THE NEW YORK SKIN AND CANCER HOSPITAL, NOW THE TUMOR CLINIC OF THE NEW YORK POST-GRADUATE HOSPITAL, NEW YORK, N. Y.

AT THE New York Skin and Cancer Hospital (now the Tumor Clinic of the New York Post-Graduate Hospital) the teaching has always been in vogue that any breast cancer, with its accessible metastases, which is removable, is operable. In view of the seriousness of the disease, any reasonable attempt to save or relieve a patient is justified.

We have divided our cases into three main groups:

Group I.—Primarily Operable Cases: Under this heading are included all those cases without definite evidence of incurability. It is our belief that all cases which are operated upon in the hope of accomplishing a cure must be classed as primarily operable. The fact that the prognosis seems unfavorable in many should not change this attitude. In this sense, all cases with axillary involvement are operable but unfavorable, as indicated by published statistics, most of which report not more than about 20 per cent of five-year results. In the same way, if we study patients with ulcerated carcinoma of the breast as a group, we find the prognosis very grave. Of our 33 cases with ulceration only two survived the five-year period. Nevertheless, if the breast is movable and there is no evidence of internal metastases, the lesion must be classed as primarily operable even though the five-year results are poor.

Group II.—Operable for Palliation: This is a group of cases with evidence of incurability. Operation is performed for the relief of symptoms. Many of the patients are referred to us after unsuccessful radiation treatment or an incomplete operation performed elsewhere. Ulcerated lesions affecting the chest wall are included, as well as patients with inflammatory carcinoma which do not permit operation within normal tissue.

Group III.—Inoperable Cases: Classed as inoperable are only those cases with the local primary tumor involving the chest wall so extensively that

* Read before the Third International Cancer Congress, Atlantic City, N. J., September 15, 1939. Submitted for publication November 6, 1939.

complete removal is impossible, or with the axillary or supraclavicular nodes involved to such an extent that they cannot be extirpated. In addition to these, all cases with known distant metastases are rejected for operation. Occasionally, however, operation may be permissible in such cases for the relief of symptoms or for the removal of a foul, ulcerating lesion.

The present report is based upon a group of 278 consecutive cases operated upon during the ten-year period, 1924–1933 inclusive. The findings are supplemented by observations based upon personal experience with the disease. At our hospital the treatment of cancer of the breast has always been primarily surgical in the operable cases. Radiation treatment, either pre- or postoperative, was used routinely during a certain period covered by this paper, and is being used to-day in selected cases. The operations were performed by an attending staff and their resident assistants, 34 in number.

Among the applicants, 505 were clinically diagnosed as carcinoma, and may be classified as follows: (1) One hundred eleven, or 22 per cent, were considered inoperable. About one-half of them were neglected primary cases, which had received neither surgical nor roentgenotherapy, while the other half were patients with recurrences and metastases. (2) Three hundred ninety-four cases were classed as operable. Of these, 116, or 23 per cent, came for consultation only, leaving 278, or 55 per cent, which form the basis of the present report.

They are divided into: (a) Primarily operable, 253 in number, selected on the basis of the criteria of operability previously defined. (b) Cases for palliative surgery, 25 in number, or 9 per cent, including local recurrences, advanced, ulcerative tumors and inflammatory lesions presenting evidence of incurability.

Mode of Onset.—Patients with carcinoma of the breast usually complain of the accidental discovery of a painless lump as the first manifestation of trouble. Some are so unobservant, however, that their attention is not drawn to the breast until there is gross deformity, ulceration, pain, or bleeding, as indicated in Table I:

TABLE I

FIRST MANIFESTATION OF CANCER

	Tumor	Ulceration	Pain	Deformity	Bleeding	Discoloration	Cracked Nipple	Not Given	Total
No. of Cases	215	15	12	12	6	1	2	15	278
Per Cent	77 3	5 4	4 3	4 3	2 1	0 4	0 8	5 4	100

Largely as the result of the educational campaigns conducted by the American Society for the Control of Cancer, and other agencies, many patients seek medical advice on the first appearance of one of these symptoms. Unfortunately, however, a large number delay because of the dread of being told they have cancer, or because they consider the manifestation not of sufficient importance to consult a physician.

The statistics detailed in Table II indicate the unnecessary delay oc-

casioned by such an attitude. This delay permits the tumor to grow from one which may be curable to one which offers a less favorable prognosis.

TABLE II

LENGTH OF DELAY BETWEEN ONSET OF SYMPTOMS AND SURGICAL CONSULTATION

21 or	7.5%	Came within 1 month
20 or	7.2%	Came between 1 and 2 months
37 or	13.3%	Came between 2 and 4 months
24 or	8.6%	Came between 4 and 6 months
Only 102 *or*	36.6%	*Came within the first 6 months*
153 or	54.9%	Came within 1 year
40 or	14.4%	Came between 1 and 2 years
20 or	7.2%	Came between 2 and 3 years
22 or	7.9%	Came after 3 years
43 or	15.5%	Onset not stated
278 or	100.0%	

Experience has shown that early operations for carcinoma lead to far better results than those performed late in the disease, no matter how radically they are performed. When a patient presents herself with a lump in the breast, it is the physician's duty not to shoulder the responsibility alone but to refer her to a surgeon for opinion and establishment of a definite diagnosis. In a large percentage of cases, a clinical diagnosis of carcinoma is possible with reasonable certainty. In all doubtful cases, and this applies particularly to the early, favorable ones, a biopsy should be suggested.

Physical Signs of Cancer.—There are definite physical signs which aid in the diagnosis of carcinoma, such as hardness of the tumor, an ill-defined border, fixation, deformity, elevation of the breast, retraction of the nipple, puckering of the overlying skin, pigskin appearance, bleeding from the nipple or enlargement of axillary lymph nodes. When all of these signs are present, the case is an advanced one and the diagnosis is, of course, easy, with a correspondingly unfavorable prognosis. It is, therefore, important to make a diagnosis when only one or two of these signs are present. No matter how small the tumor, when it is hard, ill-defined, and there is the slightest retraction of the overlying skin, malignancy has to be strongly suspected. There may be no skin retraction visible on inspection, but on elevating the breast or approximating the skin over the site of the tumor, slight dimpling may appear and should arouse suspicion. Operations performed at this stage yield the best results. Transillumination is of relatively little value.

There are types of carcinoma which do not present the physical signs mentioned above. The tumor may be smooth and freely movable and, clinically, indistinguishable from a benign growth. Because of this fact, no physician can afford to say to a patient over 30 years of age, "This lump is a harmless little gland, don't worry about it." Procrastination may cause that patient to lose her life. Whether a positive clinical diagnosis is possible or not, every breast tumor in a patient over 30 years of age should be excised and a definite diagnosis established.

Incidence of Diagnostic Signs.—Physical examination of the 278 cases herewith reported revealed the following findings of diagnostic importance:

(1) *Definite Tumor.*—These were found in 96 per cent of the cases, while in 4 per cent there was diffuse infiltration. In 20 per cent there were no physical signs except a small, hard, ill-defined, more or less movable nodule. In spite of that, 14 per cent of this group showed axillary lymph node involvement.

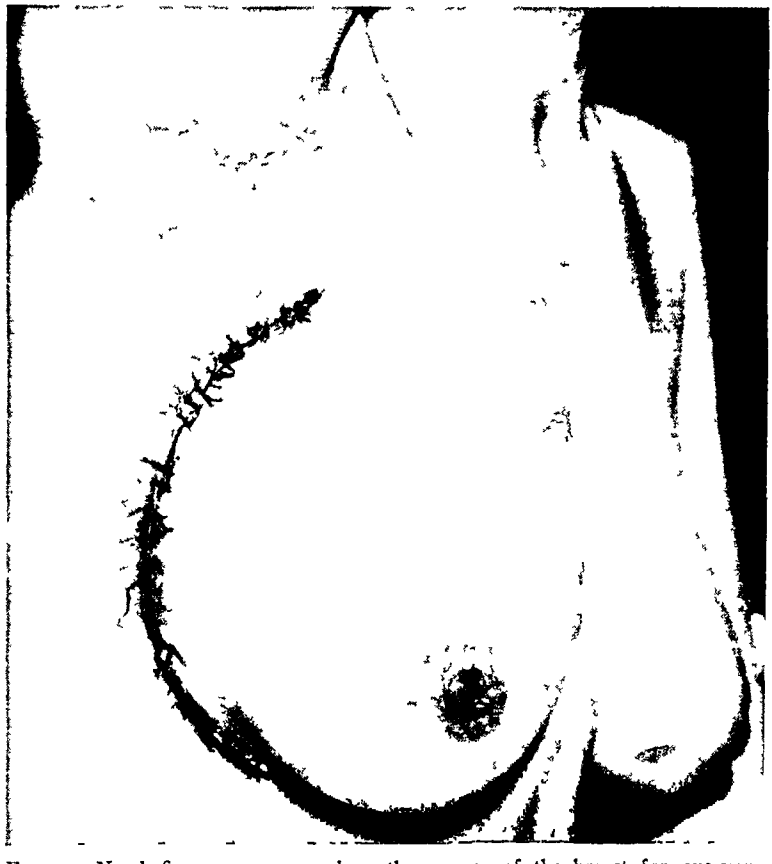


FIG 1.—Nondisfiguring incision along the margin of the breast for excision of tumors

(2) *Location of the Tumor.*—The site of the tumor was mentioned in 226 cases (Table III).

TABLE III

LOCATION OF TUMOR

	Right	Left	Total	Per Cent
Upper outer quadrant	56	54	110	48 6
Upper inner quadrant	22	14	36	15 9
Lower outer quadrant	17	18	35	15 5
Lower inner quadrant	7	8	15	6 6
Central	12	18	30	13 3
Totals	114	112	226	100

Table III shows that in 110 cases, or 48 6 per cent, the tumor was situated in the upper outer quadrant. This location is, therefore, of diagnostic importance. In this connection it may be emphasized that localized chronic mastitis, also, nearly always affects these same regions The differential

diagnosis between the two conditions is, therefore, important and, at times, so difficult that only a biopsy will clear it up. This may be undertaken without resultant disfigurement, by a semilunar incision along the outer and inferior margin of the breast, separating it from the chest wall and everting it. The entire involved area is then excised in a wedge-shaped manner, with the apex toward the nipple.

(3) *Pain.*—This was present as the first symptom in only 12 cases, or 4.3 per cent. It was present with the tumor in 46 cases, or 16.5 per cent. Pain usually means advanced disease, an infiltrating carcinoma, or association of carcinoma with chronic cystic mastitis.

(4) *Adherent Skin.*—This was mentioned in 158 cases, or 57 per cent. It is of special importance in the early cases, in which other signs are lacking, and may be the only real clue to the true diagnosis. When there is extensive deformity of the breast, pigskin appearance or ulceration, these signs naturally overshadow it.

(5) *Deformity.*—This was noted in about 25 per cent of the cases. No definite statistics are available because this condition is frequently combined with elevation of the breast or retraction of the nipple which, in themselves, produce deformity. Sometimes the breast is markedly shrunken by a gradual destructive process. In other cases it is enlarged by the presence of a massive tumor or with an inflammatory carcinoma.

(6) *Retraction of the Nipple.*—This was noted in 92 cases, or 33.1 per cent. This sign apparently indicated advanced disease, as in 88 per cent of the cases so affected there was axillary lymph node involvement.

(7) *Pigskin Appearance.*—This indicates a very malignant tumor with blocking of the ducts and edema. It is one of the chief signs in diffuse duct carcinoma, as well as in inflammatory carcinoma. It was reported in 27 instances, or 13.3 per cent.

(8) *Ulceration.*—This is usually considered a sign of advanced disease, and consequently operation is frequently withheld. In our group, there were 33 patients with ulceration. In eight, or 24.2 per cent, the axillary lymph nodes were found not to be involved. Only two cases survived the five-year period. Nevertheless, we feel that, although ulceration is usually indicative of a grave prognosis, the lesion may be operable, and may be completely extirpated together with the axillary metastases. We have, therefore, included all but four of our cases with ulceration in which no internal metastases could be demonstrated, and in which the lesions were removable, with our primary operable cases. The other four are included in our list of cases in which a palliative operation only was performed. Resection of a part of the chest wall is at times necessary. Electrosurgery finds its greatest application in this group of cases.

(9) *Bleeding Nipple.*—This was encountered in six cases; in all instances it was the first sign of malignant involvement. *The significance of bleeding and other discharges from the nipple* is a subject which requires careful attention.

Clinically, the problem is often quite difficult. If, in the presence of bleeding or other discharge, a nodule is palpable, and especially if pressure on this nodule increases the discharge, its removal and subsequent examination will clear up the diagnosis. These tumors, with their papillary ingrowths, are usually small, and are situated under or close to the border of the areola. They may be removed by a non-disfiguring incision along the margin of the areola, as shown in Figure 2.



FIG. 2.—Nondisfiguring incision along the margin of the areola for the excision of small tumors under the areola or from the adjoining breast tissue.

Frequently, however, no nodule is palpable and there is nothing to guide one in the selection of the site for the incision. Clinical experience here is of great value. Cases with serous and other discharges may be regarded as probably benign and treatment instituted to relieve them. They should, however, be kept under observation. Knowing that a large percentage of patients with bleeding nipples have carcinoma, its clinical significance should be stressed. The condition should be discussed with the patient and her family. If the bleeding persists it is important that some operative procedure be employed to determine the source of the bleeding. A simple ablation may be indicated.

(10) *Axillary Lymph Node Involvement.*—Axillary lymph nodes were palpable in 160 cases. In eight, or 5 per cent, they were later shown not to be malignant. Axillary lymph nodes were not palpable in 76 cases. Cancer was found in seven of these, or 9.2 per cent. Their presence was not mentioned in 42 cases.

Relation of Size of Primary Tumor to Axillary Metastases.—In the group of cases herewith presented, the percentage of axillary metastases is in direct relation to the size of the tumor (Table IV).

Table IV indicates that a small tumor is probably an early tumor. There is progressive axillary involvement with increasing size of the tumor. Such increase may mean that we are dealing with an old tumor, or one of rapid growth and high malignancy.

TABLE IV

RELATION OF SIZE OF TUMOR TO AXILLARY METASTASES

Size of Tumor	½ cm.	1 cm.	2 cm.	3 cm.	4 cm.	5 cm.	6 cm.	7 cm.	8 cm.	9 cm.	10 cm.	Larger Than 10 cm.	Size Not Mention	Totaled
No. of Cases...	5	12	23	50	35	24	18	11	7	5	4	18	66	278
No. of Involved Axillary Modes	1	3	7	30	24	20	17	9	6	5	4	18	52	185
Per Cent.....	20	25	30.4	60	68.5	83.3	94.4	81.8	85.6	100	100	100	78.7	66.5

Principles of the Radical Operation.—The operation employed by us bears the names of Halsted and Willy Meyer, in honor of the two men who have done most to standardize the procedure. As is well known, the essential difference between the Halsted and Willy Meyer procedure is that the former began his dissection at the sternum and worked toward the axilla, while the latter started at the axilla and dissected toward the median line in the hope of avoiding dissemination of cancer cells by manipulation of the tumor during operation.

Technic of the Operation.—We follow the Willy Meyer procedure, with some minor changes which have proved of value. The landmarks of the skin incision are the insertion of the pectoralis major muscle at the humerus, the junction of the middle and outer third of a line drawn from the clavicle to the free axillary border of the pectoralis major, and a point midway between the lower margin of the breast and the umbilicus. The variable landmarks are at the breast. The incision here surrounds the breast and depends upon the location and size of the tumor. Practically the entire skin of the breast must be removed, but this is varied slightly depending upon which quadrant of the breast is involved. All the landmarks are joined by the skin incision, which constitutes the first step. The important point is not to worry about the subsequent closure of the wound, but rather to be sure to stay well away from the tumor in order to avoid the all too frequent recurrences in the skin.

The next step is to carry the skin incision only into the superficial fat. The skin flaps are undermined and the dissection carried to the deep landmarks, which are the cephalic vein above and outward, the clavicle above, the sternum mesially and the rectus sheath below. Laterally, it extends to the free border of the latissimus dorsi muscle with its tendinous attachment to the humerus. When these landmarks are reached the entire incision is deepened to the fascia and muscles.

The actual dissection begins just above the cephalic vein on the deltoid muscle and is carried downward across the vein, taking away all fat and fascial covering of muscles and vessels. It cleans out the infraclavicular fossa above and exposes the insertion of the pectoralis major muscle at the humerus. The fibers of the pectoralis major muscle are separated from those of the deltoid. The cephalic vein marks this division. Then the entire muscular and tendinous attachment of the pectoralis major muscle is divided close

to the humerus. This preliminary step naturally means the later removal of the entire muscle including the clavicular portion. The dissection is carried over the coracobrachialis muscle.

The pectoralis minor muscle is readily exposed as it crosses the axillary vein and inserts into the coracoid process. The muscle is divided at the coracoid process, which exposes the entire axilla for careful dissection. In most cases, it is simpler to divide the broad attachment of the clavicular portion of the pectoralis major muscle at this time, before starting any dissection of the axilla, as this step immediately exposes the deep fascia covering the axillary contents, especially the axillary vein as it dips behind the clavicle which marks the uppermost portion of the axillary dissection.

A sharp scalpel is the best means of performing a thorough axillary dissection. This will remove all fat and fascia, exposing bare muscle, which will allow removal of the sheath of the axillary vein, to which are attached lymph nodes and lymph vessels. Injury to the junction of the cephalic with the axillary vein should be avoided. The only large vessels encountered, which must be divided, are the anterior thoracic artery and vein. Various other smaller vessels must be clamped and divided, the veins all being clamped within the sheath. The large nerves lying above the artery and vein should not be unnecessarily exposed. All veins entering the axillary vein from *below* can be immediately divided, the only one to be saved being the subscapular vein, which enters the axillary vein from *behind* in the outer portion of the axilla.

With the division of the deep fascia and axillary dissection the chest wall is exposed at the first rib. The highest portion of the subscapular space, way up behind the vessels, can be cleaned out by wiping it out with a gauze sponge. This is the only time that gauze dissection is employed. The long thoracic nerve of Bell, supplying the serratus magnus muscle, should be preserved. The subscapular artery and vein and nerve should also be preserved, unless they are included within a mass of involved malignant nodes, when they must be sacrificed for the sake of thoroughness.

Dissection is now carried across the chest wall from the latissimus dorsi muscle mesially, gently lifting the breast, pectoral muscles and axillary contents so that the serratus fibers may be freed of their fascia and the fibers of origin of the pectoralis minor muscle divided. The perforating branches of the internal mammary artery close to the sternum are divided and ligated with a few other branches of the intercostal vessels. Sometimes the upper rectus sheath is also removed, which leaves only the muscular fibers of origin of the pectoralis major muscle at the sternum to be divided. Thus the entire cancer field is removed *en bloc*. The high frequency current is employed for hemostasis of all smaller vessels.

A stab wound is made through the lateral flap, just anterior to the latissimus dorsi muscle, and two split-rubber tubes inserted into the axilla.

In case suture without undue tension is possible, the wound is completely closed with interrupted silk sutures. All air and fluid is expressed

from under the flaps, permitting close apposition of the skin to the chest wall. A pressure dressing is applied over the axilla.

The arm is put up in abduction and is kept that way. It is most important to do this in order to obtain early function of the arm. The first dressing is undertaken from the fifth to the seventh day, depending upon circumstances, chiefly amount of discharge, odor, or discomfort. The drainage tubes are removed at this time.

Subsequent dressings are also applied with the arm in abduction. The patient is allowed out of bed as soon as she feels like it and her general condition permits. Function of the arm is encouraged, and complete elevation is usually possible by the time the patient is discharged.

In case closure of the wound is not possible, a Thiersch skin graft from the thigh is done immediately. The graft is covered with silver foil and vaseline gauze. The dressing is not disturbed for seven days. Usually, the grafts take in their entirety.

Biopsies.—The question of biopsies requires special consideration. It is probably conceded by nearly all surgeons, that a biopsy, which consists of excision of the entire tumor with a margin of normal breast tissue, is without danger. In view of the fact that the clinical diagnosis of carcinoma is often doubtful, especially in the early cases, biopsy becomes a necessity. We have gone a step further, and in a communication,[3] in 1932, advocated excision of the entire tumor, not only for the purpose of establishing a diagnosis, but with the aim of avoiding manipulation of the growth during operation. We have always felt that some of the distant metastases to which patients finally succumb, are due to rough handling of the breast. When one considers the tendency of cancer to spread in all directions by direct extension along tissue spaces, through lymphatic channels to lymph nodes, or directly into the blood stream, it is conceivable that pressure upon the tumor itself, or upon some of the tumor emboli (Figs. 3. 4. and 5) in vessels, may propel them onward. When in addition to that, one considers that only those cancer cells which pass to the axillary lymph nodes are accessible, while those which travel along the perforating branches of the internal mammary vessels cannot be reached, the importance of trying to confine the tumor cells to the breast becomes apparent. From the moment a patient places herself under a surgeon's care he is responsible for her. Frequent or rough handling of the breast should be avoided. This applies to the preoperative period as well as to the operation itself. It is unavoidable for the assistant to pull or press on the breast during the operation. By a preliminary excision of the tumor, with either a scalpel or preferably an electrosurgical knife, this danger may be avoided.

In planning a biopsy, the patient should be prepared for a radical operaton. An incision, adequate for good exposure, is made, and the entire lesion is then excised with a good margin of normal breast tissue and fat. In case the growth is adherent to the skin, the involved portion of the latter

is also removed. Care is taken not to press upon or handle the tumor other than is absolutely necessary. In case of a favorable pathologic report, the edges of the breast tissue are approximated with a few plain catgut sutures, a split-tube drain is inserted if indicated, and the skin closed with inter-

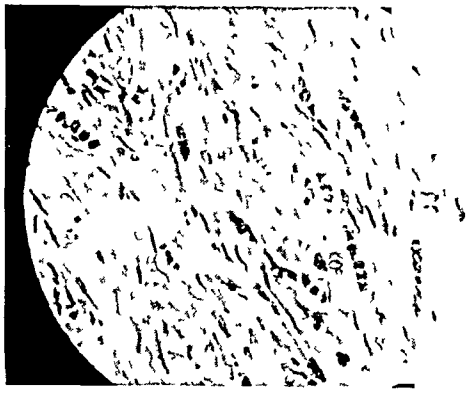


FIG 3.—Direct extension of carcinoma cells in tissue lymph sinuses

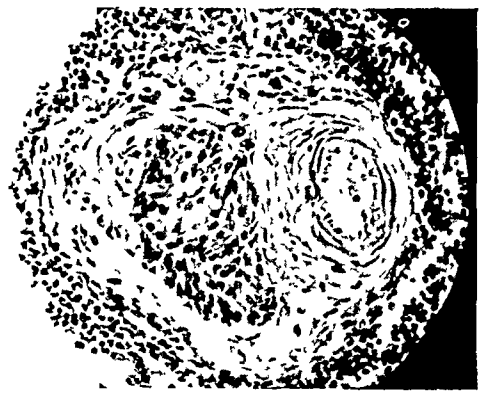


FIG 4.—Carcinoma metastasis in a vein of a lymph node

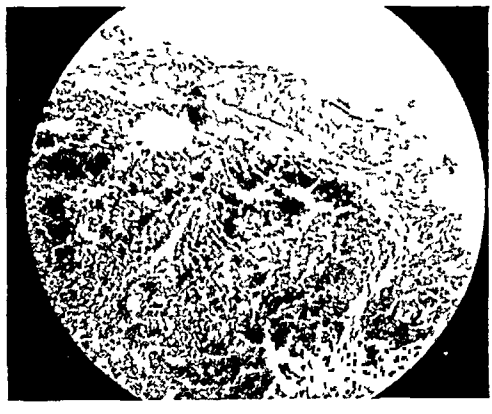


FIG 5.—Carcinoma metastasis in the lateral sinus of a lymph node

rupted silk. Should the tumor prove to be malignant, a small antiseptic tampon is inserted into the wound, the skin is closed with a few sutures, and the radical operation immediately undertaken.

Postoperative Results.—Variations in postoperative results are frequently observed in spite of the constancy of operative method and individual skill. They probably depend, to a large degree, upon differences in malignancy as well as on the extent of the disease. It may well be assumed that the majority of the patients who succumb within two years after operation, have tumors of a high degree of malignancy. It is these same cases which may have deep-seated, unrecognizable internal metastases at the time of operation, even though the axilla is negative. It is our belief that the prognosis depends on three factors: Early diagnosis; the thoroughness of the radical operation; and the degree of malignancy of the tumor. The observation that certain

tumors, classified histologically, give a higher percentage of "cures" than other groups is indicated in Table X. It is also known that certain patients have clinically favorable tumors regardless of the histology (Figs. 6 and 7 A and B). Having a large number of such favorable cases in any reported group will naturally improve the statistics.

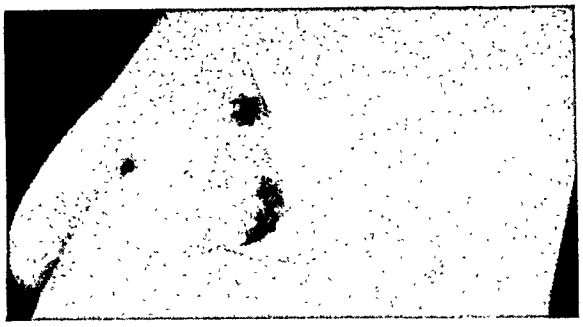


FIG. 6.—Adenocarcinoma Grade 2. "A favorable tumor." Radical operation 14 years after onset. Axillary nodes not involved.

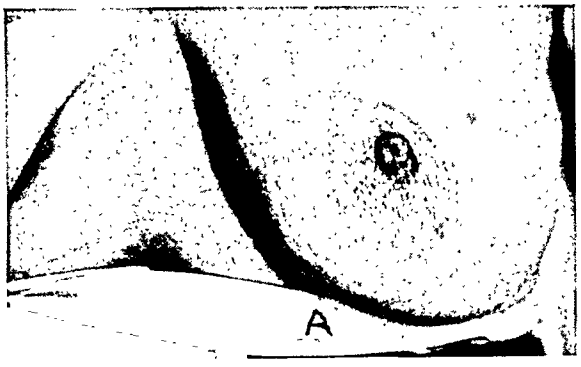




FIG. 7.—(A) Typical duct carcinoma with retraction of nipple and edema of skin, of three year's duration. Axilla involved. (B) Result eight years after operation. No signs of metastases. "A favorable tumor."

In order to permit comparison of our statistics with those of others, we have included all cases operated upon that offered a chance of cure, according to the criteria for operation enumerated above (Table V).

TABLE V

RESULTS IN ALL PRIMARILY OPERABLE CASES

Operations in cases classed as primarily operable	253
Operability	91.0%
Five-year arrests	85 or 33.5%
Ten-year arrests (of 97 cases operated upon 10 years before)	21 or 21.7%
Axillary nodes not involved	92 or 36.3%
Five-year arrests	51 or 55.6%
Ten-year arrests (of 36 cases operated upon 10 years before)	13 or 36.1%
Axillary nodes involved	161 or 63.7%
Five-year arrests	34 or 21.2%
Ten-year arrests	8 or 13.1%
Follow-up obtained on (of the total of 278 cases)	249 or 89.5%

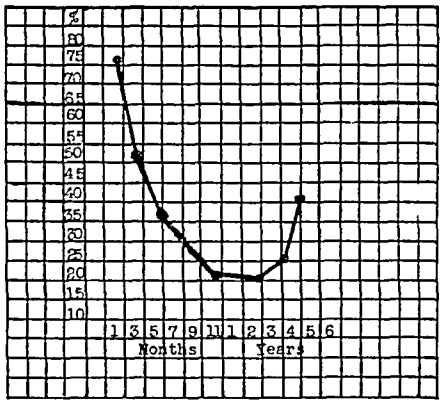


CHART 1.—Illustrating the percentage of five year arrest cases in relation to operative delay. There is a gradual reduction in five year arrests in cases in which operation was delayed from one month up to two years. After that, there is a definite increase in recoveries.

The probable explanation is that the more malignant cases die during the first two years after recognition of the tumor. Those who survive probably represent so called favorable tumors from a malignancy standpoint. Either the cells in themselves, are less malignant or the resistance of the host is greater than usual.

Prognostic Significance of Delay.—Table VI shows the relation between delayed operation and five-year arrest. This study is based upon 235 cases in which definite information was obtainable. The 43 cases in which no positive data were available have been excluded (Chart I).

Prognostic Significance of Tumor Size.—All tumors excised at our clinic are measured and studied in relation to the other portions of the breast. The statistics in Table VII show, as one may expect, that the chances of five-year arrest are better with smaller tumors, and indicates the importance of early diagnosis and operation. The smaller the tumor, the younger it apparently is, and the better the operative results.

TABLE VI

FIVE-YEAR RESULTS AS INFLUENCED BY DELAY IN OPERATING

Operated	Operated Within 1 Mo.	Between 1–2 Mos.	2–6 Mos.	6 Mos.–1 Yr.	1–2 Yrs	2–3 Yrs.	3 Yrs. (or longer)
No of Cases	21	20	61	51	40	20	22
Five-year Arrest	16	10	21	12	8	5	9
Per Cent	76	50	34	23	20	25	40 9

Tables VI and VII present statistical evidence of the importance of operating upon patients soon after discovery of the growth and while the tumor is still small. A five-year operative recovery, of about 75 per cent, in these early cases may confidently be expected.

TABLE VII

RELATION BETWEEN SIZE OF TUMOR AND FIVE-YEAR ARREST

Size	½ cm.	1 cm.	2 cm.	3 cm.	4 cm.	5 cm.	6 cm.	7 cm.	8 cm.	9 cm.	10 cm.	Over 10 cm.	Not Mentioned
No of Cases	5	12	23	50	35	24	18	11	7	5	4	18	66
Alive Five Yrs.	2	6	21	14	10	6	1	2	1	1	0	3	23
No. of Cases		40			127				45				66
Five-yr. Arrest		29			31				7				23
Per Cent		72 5			24 4				15 5				32

Roentgenotherapy.—Opinions still differ widely as to the advantages of roentgenotherapy, either before operation or after the radical operation. Largely influenced by our observation that local recurrences are rare, and that the patients who die of carcinoma after a radical operation succumb

to deep-seated regional or distant metastases, we are, at present, not using postoperative radiation as a routine, but only in cases which had axillary involvement and otherwise appear as unfavorable. Postoperative radiation, in order to be effective, would have to be administered over the whole body, but this is not feasible. To concentrate on the operative scar, axilla and mediastinum is not going to affect distant metastases though it may be valuable in destroying tumor cells in regions adjacent to the growth. We occasionally use preoperative radiation for carcinoma with a bad prognosis, especially the inflammatory type. Its value is questionable.

During a part of the period covered in the present communication, postoperative radiation was used routinely. Of the 278 cases reported, 101 had radiation in some form, four preoperatively, four pre- and postoperatively, and 93 postoperatively alone. Whereas, of the total group of 278 cases there was five-year arrest in 32.3 per cent of cases, in the group of 101 cases treated with radiation in addition to operation, there was a five-year arrest of 38.7 per cent.

The cases were not selected, and on the basis of these statistics, it appears that there may be merit in radiation following a carefully performed radical operation.

Comparative Statistics of Cases Treated Surgically.—A comparison of our statistics with those of other institutions is presented in Table VIII.

TABLE VIII

COMPARATIVE STATISTICS—FIVE-YEAR RESULTS

	Total Cases Per Cent	Without Axillary Involvement Per Cent	With Axillary Involvement Per Cent
Willy Meyer[8] (German Hosp.)	30		
Mathews[7] (St. Luke's Hosp.)	37.8		
Sistrunk and McCarthy[9] (Mayo Clinic)	36.7	63.9	18.9
Eggers[3] (Lenox Hill Hosp.)	43.8	65.4	33.3
Harrington[4] (Mayo Clinic)		71.2	26.3
Klingenstein[6] (Mt. Sinai Hosp.)	23	40	17
White[10] (Roosevelt Hosp.) 1927	36	70	19
1937	27	58	12
Eggers, de Cholnoky and Jessup (N. Y. Skin and Cancer Hosp.)	33.5	55.6	21.2

Table VIII indicates that the more recent communications present no improvement in results over the older ones. Willy Meyer's[8] report, in 1905, which includes all his cases since he proposed the radical operation in 1894, and presents 30 per cent five-year results obtained in unselected cases, is as good as those reported from most clinics to-day, even with the addition of postoperative radiation. White's[10] communications, in 1927 and 1937, are interesting as showing that in spite of becoming more radical in his operative procedure and adding postoperative radiation, his statistics, in 1937, are well below those of 1927. As he himself states, this may be due to more accurate pathologic reports and a better follow-up. Perhaps uniform criteria of operability will aid in comparing statistics.

We would like, at this point, to refer to an article on cancer by one of

us,[3] in which a group of 80 consecutive, personal cases of breast cancer is reported. They represented all types of cancer and all degrees of severity. No radiation was employed. Emphasis was placed on wide excision of the tumor, thorough undermining of the skin and careful dissection. The total five-year arrest of the disease occurred in 43.8 per cent. The most striking result, however, was obtained in cases with axillary involvement, showing five-year arrest of the disease in 33.3 per cent of the cases, which is considerably higher than the recoveries reported from most clinics. We have attributed these results to careful surgery in the advanced cases. A comparison of the statistics of this group and the one reported herewith is presented in Table IX.

TABLE IX

COMPARATIVE STATISTICS

	Eggers (Lenox Hill Hosp.)	Eggers, de Cholnoky and Jessup, (N. Y. Skin and Cancer Hospital)
Total cases	80	253
Operability	94 5%	91 0%
Five-year arrests	43 8%	33 5%
Ten-year arrests	15 0%	21 7%
Axillary nodes not involved	32 5%	36 3%
Five-year arrests	65 4%	55 6%
Ten-year arrests	18 3%	36 1%
Axillary nodes involved	67 5%	63 7%
Five-year arrests	33 3%	21 2%
Ten-year arrests	10 0%	13 1%
Follow-up	95 0%	89 5%

It raises the question—what is responsible for such marked differences in two groups in which practically the same criteria of operability and similar radical technic was employed? It appears to us that in addition to variability in degree of malignancy we may attribute them to two factors: (1) Poorer material in our clinic cases, which is about the least favorable imaginable. (2) Cases operated upon by one operator, with a well-developed technic, are likely to give better results than a group operated upon by 34 different surgeons, some of whom are just learning the technic.

Bilateral Cancer of the Breast.—It is known that about 5 per cent of patients with breast cancer develop a tumor in the opposite breast, either simultaneously or sometimes months or years after the first breast was removed.

It is interesting to speculate on whether the tumor is a metastasis from the primary growth or whether it is an independent lesion. Sometimes one, then the other theory, seems to apply. Occasionally the second involvement appears to be a direct extension across the median line.

In case the appearance of a tumor in the second breast coincides with the presence of deep-seated metastases, or if it shows the same pathologic structure, or if it appears simultaneously with, or soon after, the first growth, one may assume that metastatic involvement is the most likely explanation. On the other hand, if the second breast becomes involved only after several years, if there is no evidence of other metastases, and the patient remains

well for years after the second operation, one may reasonably assume that the tumor was an independent lesion.

It is our belief that, in the absence of proved metastases, a radical operation should be performed for malignant involvement of the second breast.



FIG. 8.—Radical operation for bilateral carcinoma. Note good functional result.

The same criteria of operability which apply in unilateral, should be applied in bilateral cases. All such cases should, therefore, be included in statistics of primarily operable lesions. The functional result after bilateral radical operation is good (Fig 8).

There were nine cases in our group, of which five, or 55.5 per cent lived beyond the five-year period, from the time of the first operation. One patient is living to-day, 12 years after the first operation. The axilla on one side was involved. One case died, six years after a bilateral operation, while two patients were lost from follow-up, six years after a bilateral operation performed the same year. Both were well when last seen and, in view of the fact that both had a cystadenocarcinoma, which is rated as a low grade tumor, it is possible that they are still alive. The other cases lived five, four and one-half, four, two and one year, and usually died soon after the second operation.

Supraclavicular Lymph Node Involvement.—This condition is rarely pres-

ent at the time primarily operable cases come under observation and, therefore, does not play a rôle in determining operability. During the ten-year period covered by this present report, 21 cases with supraclavicular enlargement were observed. Six cases may be eliminated because they were old, advanced, recurrent cases in which the primary operation had been performed elsewhere. One patient was not operated upon. This leaves 14 cases for consideration. In only one were the nodes present and removed at the time of the radical breast operation. It was evidently a bad case, because death resulted three months later. Two cases were operated upon within a month after the first radical operation, and the nodes showed only an hyperplasia. In the other 12 cases, the operation was performed in from several months to four years after the radical operation. All showed carcinomatous involvement.

Enlarged nodes were palpable in	15 cases
Not operated upon	1 case
Operated upon	14 cases
Involved with carcinoma	12 cases
Hyperplasia	2 cases
Follow-up on	10 cases
No follow-up on	2 cases

Of the patients who were operated upon for supraclavicular involvement the following follow-up was obtained:

Dead Within	1 yr.	2 yrs.	3 yrs.	3½ yrs.	4 yrs.
No. of Cases	5	2	1	1	1

No case survived the five-year period, and it is questionable whether the operation is of any real value. When involved, there are usually other deep-seated metastases in the mediastinum. However, in view of the almost negligible mortality attending this operation, it is justified when a patient shows isolated supraclavicular nodes with no definite evidence of distant metastases. The nodes may sometimes be controlled for a time with irradiation.

Local Recurrences.—By local recurrences, we understand secondary growths, appearing some time after the radical operation, within the field of operation. This means in the skin along the line of incision, in the subcutaneous tissue, in muscle remnants or in the axilla. It is our feeling that the surgeon is responsible for such local recurrences, in that they indicate that not sufficient skin was removed or that the deep dissection was not adequate.

Secondary growths appearing in tissues adjacent to the field of operation, such as the ribs, cartilages, intercostal tissues, anterior mediastinal and supraclavicular lymph nodes are not classed as recurrences but as regional metastases. No attempt is made during the radical operation to remove any of these tissues, and the surgeon is, therefore, not responsible for the appearance of metastases in them.

With this clear understanding, we report local recurrences in 17 cases, or 6.7 per cent, in the 253 primarily operable cases, in which the radical operation was performed by our own staff. The percentage of local recur-

rences is really an index of the efficacy of the operative procedure. With the statistics reported by us, which include all types of cases, favorable as well as unfavorable, we believe that local cure may confidently be expected in all breast cancers in which the growth is limited to the breast and the axilla. Those patients who subsequently die, rarely succumb to a recurrence of the growth locally, but to internal metastases. When one is dealing with a tumor fixed to the chest wall, an ulcerated growth, or an inflammatory carcinoma, local recurrence may be expected. The treatment of local recurrences depends upon their nature. If suitable, excision with the scalpel or electrosurgical knife may be undertaken, with or without resection of a portion of the chest wall. In other cases, palliative roentgenotherapy is indicated.

Edema of the Arm.—Chronic lymphedema of the arm is an unsightly and quite a disabling complication, which may be due to different causes. Judging from the fact that ligation of the axillary vein in several cases has not resulted in edema we believe it to be usually due to lymphatic blocking and only rarely to a phlebitis. A slight edema may be transitory or persistent, and is probably due to complete extirpation of the axillary lymph nodes with consequent interruption of lymph channels. We believe that chronic edema may be due to several factors: (1) Tight bandaging of the arm in a cramped position. (2) Unduly prolonged immobilization of the arm. (3) Postoperative roentgenotherapy. (4) Acute lymphangitis. (5) Phlebitis.

In our experience, it is an uncommon complication. We attribute this to the avoidance of the factors just mentioned. By putting the arm up in abduction and allowing free elbow motion from the start, good circulation in the arm is possible. Early elevation of the arm is encouraged and patients are taught exercises. They usually have a good range of motion at the time of discharge.

Although it cannot be proved, we have the definite clinical impression that early postoperative radiation favors the development of chronic edema, probably due to blocking of lymphatics by the formation of connective tissue before collateral lymphatic circulation has developed. At times, one sees acute edema developing several weeks after a perfectly normal convalescence. It is associated with redness and local heat, and corresponds to the clinical picture of acute lymphangitis. There is no other evidence of infection, and the condition subsides with elevation of the arm, rest, wet dressing, and ice bags.

When a chronic edema is definitely established it is most resistant to treatment. A daily period of elevation of the arm on several pillows, with the patient reclining, is of value. An elastic bandage applied lightly during the night will also aid in relieving the feeling of weight and tension.

Table X shows a pathologic classification which includes some terms that were in vogue 15 years ago, which have since been discarded by many pathologists—scirrhus and medullary being now employed as qualifying the general, broader designation of adenocarcinoma.

While histologic grading has been applied to these 278 cases, the re-

sults have not been tabulated here, for it has seemed to us that even with the most careful study of sections the conclusions, if offered to the clinician, are often misleading and that the most important feature in the study of breast tumors is the question of whether the growth is malignant or not.

TABLE X

PATHOLOGIC CLASSIFICATION

		Per Cent	Five-year Arrest	Per Cent
Scirrhus carcinoma	151	54 3	46	30 4
Medullary carcinoma	57	20 5	16	28 1
Adenocarcinoma	43	15 4	16	37 1
Paget's disease	5	1 8	3	60 0
Cystadenocarcinoma	4	1 4	2	50 0
Mucoid carcinoma	1	0 3	1	
Sarcoma	1	0 3	1	100 0
Basal cell carcinoma	1	0 3	1	
Unclassified carcinoma	15	5 4	6	40 0
Totals	278	100 0	92	32.2

If malignant, the treatment will be the same whether grade 1 or grade 3, and every patient is entitled to the standard radical operation where cancer is diagnosed.

Suggestions for Improving Results.—With the most favorable cases of cancer, those with a small movable tumor and no axillary lymph node involvement, the highest number of five-year results may reach 75 per cent, but it usually varies between 60 and 70 per cent. In the remaining 30 or 40 per cent of cases, death ensues some time within the five-year period, a large percentage dying within two years after operation. These patients rarely succumb to local recurrence, but die of internal metastases. We must assume, therefore, that even in this favorable group, cancer cells have spread from the local primary tumor into the body before or during the operation. The length of life of these patients depends upon the degree of malignancy of the tumor and upon the importance of the secondarily involved organs.

In patients with axillary involvement, ulceration, or bilateral cancer, the results are infinitely worse. The reports from large centers indicate that usually only about 20 per cent survive the five-year period, and frequently less.

Surgeons are alert to the need for salvaging a larger percentage of cases than is done at present. The following suggestions are offered in the hope of improving results:

(1) *Early Cases; Without Axillary Lymph Node Involvement.*—Many of the so-called early tumors must have been present longer than suspected, as indicated by the subsequent appearance of internal metastases. The question of earlier diagnosis and operation has to be approached from two points of view: (A) Education of the public to consult their physician regarding any breast symptoms, especially if a lump be present in the breast. (B) Continued education of the physician that any tumor of the breast should be considered a serious finding calling for immediate investigation. Early surgical

consultation is indicated and one should never hesitate to have a biopsy performed in order to reach a positive diagnosis. Other important factors to bear in mind are: (C) Avoid rough handling of the breast during examination. (D) Excise all breast tumors, especially in patients over 30 years of age, even if no definite signs of malignancy are present. (E) Practice wide preliminary excision of the tumor in contemplated radical operations, in order to prevent the spread of malignant cells by manipulation during operation. (F) Follow the old teaching "a small cancer, an extensive operation." Therefore, perform a radical, painstaking operation in all cases.

(2) *Advanced Cases.*—Those with gross axillary involvement, ulceration or bilateral breast cancer, but considered primarily operable. To be able to improve results in this group of cases, is a challenge to surgeons. It is our conviction that with careful handling of the breast; preliminary excision of the growth; thorough undermining of the skin; and the most meticulous clean dissection, good results may be expected in a fair percentage of cases. When comparing our five-year results in private cases with lymph node involvement with those published in reports from the larger centers, we feel that our contention for radical surgery has been justified. It is in this group of cases that local postoperative radiation may be of value.

SUMMARY

An analysis of 505 cases of breast cancer is presented from the Skin and Cancer Unit of the New York Post-Graduate Hospital. Being known as an institution devoted to the treatment of cancer, many patients came for consultation only, while others applied for relief from inoperable lesions.

One hundred eleven, or 22 per cent, had metastases which were internal or were irremovable and, therefore, inoperable. Three hundred ninety-four were considered operable. Of these 116, or 23 per cent, came for consultation only, leaving 278, or 55 per cent, which form the basis of this report. They are divided into two main groups:

Group I.—Primarily Operable Cases (253 in number): Definite criteria for operability are presented. They include all cases without demonstrable distant metastases, in which the entire breast, with its accessible lymph node metastases, can be removed. Cases with ulceration, supraclavicular involvement, and bilateral breast cancer are included.

Group II.—Cases for Palliative Surgery: Our group is composed of 25, or 9 per cent, of the cases, including local recurrences, advanced ulcerated tumors, and inflammatory carcinomata presenting evidences of incurability.

The prognostic significance of delay; size of tumor; axillary involvement; and subsequent prognosis is presented on the basis of five- and ten-year results.

The routine radical operation for primarily operable cases is described.

Preliminary excision of the tumor is advised in radical operations to avoid manipulation of the growth and the spread of cancer cells during operation.

By the two tests at our disposal for judging the efficacy of the radical operation for cancer of the breast—longevity and local recurrence—we may conclude that a carefully performed operation is successful in curing the disease locally.

A defeatist attitude and a timid approach to the subject spell failure.

Complications and sequelae are presented under the different headings of bilateral involvement; supraclavicular involvement; the significance of bleeding from the nipple and other discharges; ulcerated breast carcinoma; local recurrence; and chronic edema of the arm.

Mention is made of the value of radiation treatment.

A pathologic classification is submitted with five-year results in each group.

Suggestions for improving results are discussed.

Five-year arrests were obtained in cases without lymph node involvement in 55.6 per cent; with lymph node involvement in 21.2 per cent. Ten-year arrests were obtained in cases without lymph node involvement in 36.1 per cent, with lymph node involvement in 13.1 per cent.

These statistics, though they indicate a relatively low percentage of "cures," appear quite favorable when viewed in the light of the poor clinical material from which they were obtained, and the fact that they were operated upon by 34 different surgeons.

REFERENCES

[1] Adair, Frank: The Effect of Preoperative Irradiation in Primary, Operable Cancer of the Breast. Am. Jour. Roentgenol., 35, No. 3, 359–370, March, 1936.

[2] Cholnoky T. de: Benign Tumors of the Breast. Arch. Surg., 38, 79, January, 1939.

Idem: Electrosurgery in Advanced Cancer. ANNALS OF SURGERY, 103, 415, March, 1936.

[3] Eggers, Carl: Radical Operation for Carcinoma of the Breast. ANNALS OF SURGERY, 96, 1098, December, 1932.

Idem: Cancer Surgery. ANNALS OF SURGERY, 106, 668, October, 1937.

[4] Harrington, Stuart W.: Carcinoma of the Breast. Surg., Gynec., and Obstet., 56, 438, February, 1933.

[5] Hoffman, William J.: The Value of Irradiation in Cancer of the Breast. New York State Jour. Med., 39, No. 15, 1481, August 1, 1939.

[6] Klingenstein, Percy: Late Results in the Operative Treatment of Carcinoma of the Breast. ANNALS OF SURGERY, 96, 286, August, 1932.

[7] Mathews, Frank S.: Results of Operative Treatment of Cancer of the Breast. ANNALS OF SURGERY, 96, No. 5, 871–881, November, 1932.

[8] Meyer, Willy: An Improved Method—Radical Operation for Carcinoma of the Breast. Med. Rec., 46, 746–749, December 15, 1894.

Idem: Carcinoma of the Breast. J.A.M.A., 45, 297–313, July 20, 1905.

[9] Sistrunk, W. E., and McCarthy, W. C.: Life Expectancy Following Radical Amputation for Carcinoma of the Breast. ANNALS OF SURGERY, 75, 61, January, 1922.

[10] White, William C.: Late Results of Operation for Carcinoma of the Breast. ANNALS OF SURGERY, 76, 695, November, 1927.

Idem: Postoperative Roentgenotherapy in Cancer of the Breast. ANNALS OF SURGERY, 108, 21, July, 1938.

NIPPLE DISCHARGE

A CLINICOPATHOLOGIC STUDY

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THIS report is based upon a study of 67 patients, who had a discharge from the nipple. All types of nipple discharge were included because our experience demonstrated the danger of focusing attention on bloody discharge only. The cases were found by reviewing records of all breast cases seen in the Tumor Clinics of the Massachusetts General Hospital and the Boston Dispensary. From May, 1925, to January, 1939, 69 cases, or 7.6 per cent of 898 patients seen in the Massachusetts General Hospital Tumor Clinic, had nipple discharge. From January, 1932, to December, 1938, 19 cases, or 12.4 per cent of 153 patients at the Boston Dispensary Tumor Clinic, had nipple discharge. Thus, 8.3 per cent of 1,051 patients coming to the two clinics had nipple discharge. Excluded from this series are patients with discharge from inverted nipples, and patients with Paget's disease in whom a discharge came from an ulcerated nipple. In only 67 cases of a total of 88 were the records and clinical data adequate to warrant their inclusion in this report.

In 52 instances, operation had been performed. Slides were reviewed in all but five of these cases. In 15 cases, either no surgery had been advised, or the proffered surgery had been refused, but all these patients were under observation for a period sufficient to justify inclusion. In several patients a positive diagnosis of carcinoma of the breast was established by the clinical course which subsequently progressed to a fatal termination. The composition of a series of patients with nipple discharge, who come to a Tumor Clinic, is not altogether representative, because a number of patients and doctors find their own solution to the problem, unless the discharge is bloody or a tumor is also present.

Discharge from the nipple may be discussed under three headings: (1) Frequency. (2) Type of discharge. (3) Etiology of discharge.

Frequency.—Some type of discharge from the nipple occurs in about 8 per cent of all mammary lesions. A sanguineous discharge occurred in 6 per cent of 5,118 patients coming to the Johns Hopkins Hospital because of a breast complaint.[30] Deaver and McFarland[21] stated that 3 to 5 per cent of breast cancers are accompanied by a discharge. Geschickter[29] reported a bloody nipple discharge in 96 of 204 cases (47 per cent) of duct papilloma. In a series of chronic mastitis cases, MacCarthy and Mensing[61] found that 6.6 per cent of 406 patients manifested a discharge from the nipple.

Type of Discharge.—Certain generalizations are valid. A sanguineous dis-

Submitted for publication October 19, 1939.

charge should arouse more concern than a nonsanguineous one. When a duct papilloma is responsible, discharge is often serosanguineous. A dark, bloody discharge is commonly caused by a duct carcinoma. However, too much emphasis must not be placed on such correlation. It is particularly important to appreciate that the presence of a carcinoma cannot be excluded because the discharge is free of blood. Two forms of breast discharge have diagnostic significance: (1) A grumous, greenish yellow discharge is almost always due to stasis in dilated ducts. (2) A continuous, milky discharge, often bilateral, is galactorrhea. The incidence of various types of discharge in this study is shown in Table I.

TABLE I

INCIDENCE OF TYPES OF DISCHARGE

Bloody (including serosanguineous)	36 (54%)
Serous	16 (22%)
Milky	5 (7%)
Watery	2 (3%)
Miscellaneous	8 (13%)

Etiology of Discharge.—The experience of a number of investigators has shown that the three most common causes of discharge from the breast are duct papilloma, carcinoma, and chronic cystic mastitis, in that order of frequency. If bloody discharge only is studied, slightly more than one-half of the cases are due to a benign lesion. The incidence of chronic mastitis, as the cause of a bloody discharge, ranges from 7 per cent (Adair) to 15 per cent (Geschickter). Since this report deals with all types of discharge, it is not surprising to find that chronic mastitis was the etiologic factor in 27 per cent of our cases.

Other conditions may be enumerated. Nonspecific infections of dilated ducts are often accompanied by nipple discharge. Clinical evidence suggests an endocrine factor in some cases, although Taylor[80] was unable to confirm this by laboratory studies on a large group of women. Rare causes are trauma, sarcoma, fibro-adenoma, luetic and tuberculous mastitis. Table II shows the causes of discharge in our 67 patients, eight of whom had bilateral discharge.

TABLE II

CAUSES OF NIPPLE DISCHARGE IN 67 PATIENTS

Carcinoma (excluding Paget's disease)	22 (33%)
Paget's disease	2 (3%)
Chronic cystic mastitis	18 (27%)
Duct papilloma	7 (10 5%)
Hormonal dysfunction	7 (10.5%)
Inflammatory cysts	3 (4%)
Fibrous mastitis	2 (3%)
Miscellaneous	6 (9%)
Total	67

In 15 patients not operated upon, only a clinical diagnosis was available. However, in any similar group, there will be a number of patients in whom no indication for surgery is apparent, yet reasonably accurate diagnoses may be made. This source of error was minimized by the exclusion from this report of 24 patients whose records were inadequate.

Pathology.—About 75 per cent of the cases of nipple discharge are due to three lesions: (1) Carcinoma; (2) papilloma; and (3) the proliferative phase of cystic disease of the breast (Schimmelbusch's disease or adenosis). The carcinomata associated with nipple discharge are often the more localized, slowly growing papillary or comedo types. The majority of papillary carcinomata are thought to represent a late development in preëxisting benign papillomata. Geschickter noted that about one-third of the comedo carcinomata in his series (106 cases) occurred "in breasts which were the seat of adenosis." It is our opinion that this phase of cystic disease of the breast is a precancerous lesion, as is the duct papilloma, but to a lesser degree.

A fairly well standardized attitude prevails toward abnormal discharge from other body orifices, particularly a bloody discharge. No such agreement exists with regard to nipple discharge, bloody or otherwise. It is the purpose of this communication to stress the importance of nipple discharge as a sign which should make the observer search for an actual carcinoma or a precancerous lesion in the affected breast. In many cases, neither will be found, but only by such search is the patient's welfare adequately safeguarded.

Duct papilloma is widely acknowledged to have a potentiality for carcinomatous degeneration. Controversy centers upon chronic cystic mastitis and especially the actively proliferating lesions characterized by epithelial overgrowth in dilated ducts and small cysts (Schimmelbusch's disease, adenosis of Lewis and Geschickter,[56] cystipherous desquamative epithelial hyperplasia of Cheatle and Cutler)[14] (Fig. 1). In the literature, there is scant attention given to this lesion as a cause of discharge from the nipple. Auchincloss[3] stated that unexplained nipple discharge occurs most often from breasts containing cysts with epithelial proliferation. He added that this is the group of benign breast lesions most commonly associated with cancer. Geschickter reported that 47 of 211 benign cases of bloody nipple discharge were due to this lesion. Robles and Banno[73] declared that it was the most frequent type of benign lesion associated with bleeding from the nipple.

The consensus of present opinion holds that cystic disease, in general, is not a precancerous state. However, there is accumulating an increasing volume of evidence to suggest that cystic disease with epithelial hyperplasia is precancerous, although the supervention of malignancy may occur less frequently than is the case with the papilloma. In Warren's[84] recent study in which he concludes that chronic cystic mastitis predisposes to the development of breast cancer, he stresses the importance of this epithelial hyperplasia. Such cases comprise about 14 per cent of all cases of cystic disease of the breast, according to Lewis and Geschickter,[58] and 9 to 12 per cent of them show nipple bleeding.

In our series, 13 women were proven, histologically, to have chronic cystic mastitis. Ten of the specimens were associated with epithelial hyperplasia. Four of our patients were over 55 years of age. The slides from these four cases were shown to four Boston pathologists, all of whom regarded the lesion as precancerous. Moreover, histologic study of the 22 breast cancers with



FIG. 1.—Case G. T. (M.G.H. East Surgical, No. 332503): Section shows the proliferative phase of chronic cystic mastitis (Schimmelbusch's disease or adenosis). This breast contained many small cysts. Note the benign papillary hyperplasia. The patient was 55 years of age. Pathologists to four large Boston hospitals were unanimous in regarding this lesion as precancerous. (X180)



FIG. 2.—Case M. M. (B. D., No. 228908): Section showing dilated ducts lined by hyperplastic epithelium. This is Schimmelbusch's disease. In the same area of the breast, there was also a metastasizing adenocarcinoma, which could not be felt prior to operation. (X180)

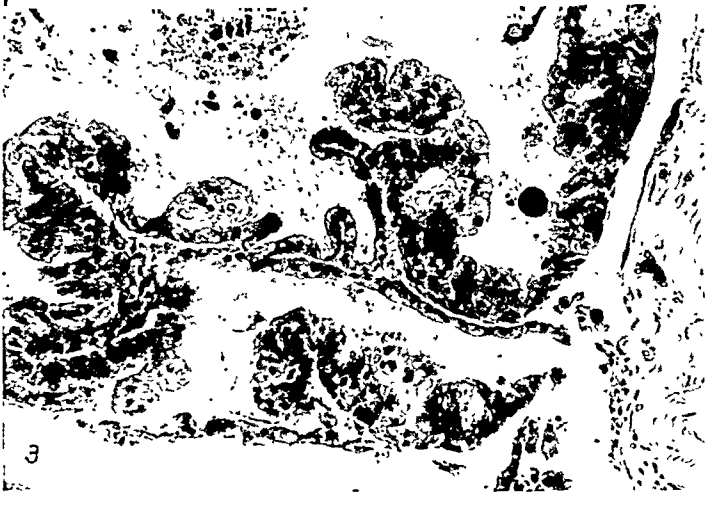


FIG. 3.—Case B. E. (B. D., No. 346749): This patient was 65 years old. This section was diagnosed as chronic cystic mastitis with marked intraductal epithelial hyperplasia. In the opinion of Dr. Shields Warren, pathologist, this lesion was definitely precancerous. A simple mastectomy was performed. (X240)

nipple discharge revealed that in six cases there was a marked degree of similar epithelial hyperplasia within the ducts, located in the same sector of the breast, in which the invasive, neoplastic epithelium had been found. In two of the six, the diagnosis of comedo carcinoma was warranted. In two other cases, the pathologist had already commented upon the presence of the Schimmelbusch type of proliferating epithelium seen in the same slide in which the carcinoma was present. Cheatle[14] argues that this more than occasional coexistence of Schimmelbusch's disease and carcinoma is not mere coincidence. Warren's careful appraisal of their relationship led him to believe that the former condition predisposed to the latter. Geschickter,[20] who has been a strong advocate of the benignancy of chronic cystic mastitis, recently acknowledged that about one-third of the comedo carcinomata in his series occurred in breasts which were the seat of adenosis. The study of our clinical and histologic material has aroused the conviction that this epithelial overgrowth has a potentiality for malignant degeneration.

In an analysis of the 67 patients considered in the present study they were divided into eight groups according to etiology. These groups will be discussed in order of their frequency.

Carcinoma.—Twenty-four of 742 cancers of the breast (3.2 per cent) were accompanied by some form of discharge from the nipple. Two of these were Paget's disease. The average age was 50 years. Ten of the remaining 22 women had a bloody discharge, while 12 had a nonsanguineous discharge. In five cases the discharge was regarded as incidental, usually because it was very slight in amount and appeared long after the obvious tumor. In 17 cases the discharge was significant. A study of these 17 women is profitable. In a number of instances, the correct diagnosis was not established until long after the onset of the discharge. Four common sources of diagnostic error were apparent: (1) The youth of the patient; (2) the fact that the discharge was not bloody; (3) the discharge was the first symptom; and (4) the absence of a palpable mass in the breast.

(1) Two young women, 32 and 26 years of age, had bloody nipple discharge, painful breasts, but no mass when first seen. In both, the affected breast was described as "shotty," and in one patient this nodularity was localized in the upper, outer quadrant. Such localized nodularity Cutler[17] proclaims as "a sign of great gravity," signifying the Schimmelbusch stage of chronic cystic mastitis. In one case three years elapsed before the discovery of an axillary metastasis brought about radical mastectomy, and the disclosure of an impalpable carcinoma (Fig. 2). This tumor was situated in an area of marked intraductal epithelial proliferation. In the second case, mastectomy performed one year later because of increasing nodularity demonstrated a comedo carcinoma with early invasion.

(2) There appears to have been undue emphasis on the bloody nature of nipple discharge. It is noteworthy that more than one-half the patients with cancer, in this study, had a discharge which was at no time bloody. Four women had a serious discharge. In three of them, a clinical diagnosis of

chronic cystic mastitis had been made despite the presence of a mass in the breast. This suggests that the absence of blood in the discharge persuaded observers that the lesion was benign.

Case Report.—M. G. H., East Surgical, No. 291743: G. L., female, age 25, who had been under treatment for pelvic inflammation, was found to have a discharge of thick serum coming from her right breast in which four separate nodular areas were present. A diagnosis of chronic cystic mastitis was made. Four months later she was first examined in the Tumor Clinic. Operation disclosed a rapidly growing cancer from which the patient died in two years.

(3) In 11 women, a discharge from the nipple had been the first indication of pathology in the breast. At their first Tumor Clinic visit seven of them also had a mass. The discharge preceded detection of a breast mass in these seven cases by an average of 12 months. Early cancer of the breast is more commonly associated with a discharge from the nipple than with any other sign except the presence of a lump. It is the first sign in about 1 per cent of all breast cancers.

(4) Four women had no palpable tumor in the breast when first examined. Three of them had a bloody discharge. All four breasts were abnormal, two showing localized nodularity in the upper outer quadrant, the other two presenting diffuse lumpiness. The four women had been observed for periods ranging from eight months to four years, before the diagnosis of cancer was established. Two young women received a small amount of roentgenotherapy to the breast, as suggested by Adair[1] in 1931. Discharge lessened but did not cease. In three of these four patients, the periodic clinic notes detail a steadily progressing process in the upper outer quadrant, with increasing confluence of nodularity, culminating in a demarcated area of induration which compelled biopsy. In the fourth case, no breast tumor was detected but an axillary metastasis required surgical intervention.

We concur with Wainwright's[83] dictum that the entire breast should be removed in those cases of nipple bleeding wherein no localized focus is clinically demonstrable. The bleeding breast with no tumor must be suspected of harboring not only a papilloma or precancerous epithelial hyperplasia, but even an actual, impalpable carcinoma.

Chronic Cystic Mastitis.—There were 18 cases of chronic cystic mastitis. In five patients, the diagnosis was based upon clinical evidence only. The discharge was bloody in seven women, serosanguineous in four, serous in four, and three women had a milky, a greenish, and a brownish discharge, respectively. The average age was 44. The physical findings were variable. Only three cases conformed to the clinical picture of Schimmelbusch's disease (*i.e.*, localized nodularity). However, clinical detection of this menacing phase of cystic disease is unreliable. Ten women had intraductal papillary epithelial hyperplasia. The nipple discharge contained blood in nine of these ten.

Case Report.—B. D., Tumor Clinic, No. 2449: M. A., female, age 42, had had simple mastectomies at a three-year interval, because of bloody nipple discharge. Neither breast was abnormal to palpation. However, in one breast there was marked papillary

proliferation, whereas its mate contained only a few small, blue-domed cysts and increased connective tissue.

Whatever concessions one may make to the general proposition that cystic disease is not precancerous, marked epithelial growth in the breasts of elderly women must occasion alarm. Two women, 68 years of age, are illustrative.

Case 1.—B. D., No. 329407: E. C. had manifested nipple bleeding for six months. No tumor was palpable. A radical mastectomy was performed because of the pathologic report—intracanalicular papillary adenocarcinoma. However, a review of the slides shows a benign lesion consisting of papillomatous infoldings of hyperplastic epithelium, with normal cell detail, and no invasion.

Case 2.—B. D., No. 346749: B. E. had had a lump in the breast for five years, intermittent, yellowish discharge. There was a diffuse, indurated area lateral to the nipple. A clinical diagnosis of Schimmelbusch's disease was confirmed microscopically. It was the opinion of Dr. Shields Warren,[84] who has recently published a study of this problem, that the lesion was to be regarded as precancerous, not only with respect to comedo carcinoma, but also to ordinary infiltrating carcinoma (Fig. 3).

The conclusion seems warranted that in cases of nipple discharge associated with a nodular breast, particularly if the discharge contains blood, the majority of such breasts will show epithelial hyperplasia. The disposition of this group will depend upon the surgeon's attitude toward the life history of such epithelial activity.

Duct Papilloma.—Seven duct papillomata were found. In the literature, papilloma and carcinoma have an equal rôle in accounting for about 90 per cent of the cases of bloody nipple discharge. The papillomata are located in the larger ducts, often under the areola. They are often bilateral and are multiple in the same breast in about 30 per cent of the cases. A nipple discharge, usually serosanguineous, occurs in 50 per cent. The lesion is frequently impalpable but may be detected by transillumination, if bleeding has occurred, as the blood delineates the papilloma. Sometimes the diagnosis can be made by detecting a small area of thickening under the areola, pressure on which evokes the nipple discharge.

Adair has estimated that the supervention of carcinoma requires 10 to 12 years. By that time a palpable mass is almost always present. However, there have been a number of cases in which the malignant transformation had occurred, yet the only evidence of its presence was the discharge from the nipple, Bloodgood, who has said that a woman with nipple discharge and no tumor runs no more risk of cancer than a woman who has neither, nevertheless sought for and removed papillomata even although impalpable.

Two of our seven patients had a nonsanguineous discharge. Six simple mastectomies were performed, but frequently the lesion can be removed by local excision. In a seventh patient, the diagnosis was made by transillumination. On microscopic study, the diagnosis of a benign lesion is occasionally difficult.

Case Report.—M. G. H., East Surgical, No. 298127: M. A., female, age 32, had had occasional slight bleeding from left nipple for 12 years. Examination showed a small,

hard mass underneath and adherent to the areola. The original pathologic diagnosis was papillary adenocarcinoma of low malignancy. However, current review of the sections demonstrates that the lesion is benign (Fig. 4).

In the 22 breast carcinomata in this study, there were three in which the clinical evidence and pathologic appearance suggest their origin in a pre-existing benign papilloma (Fig. 5).

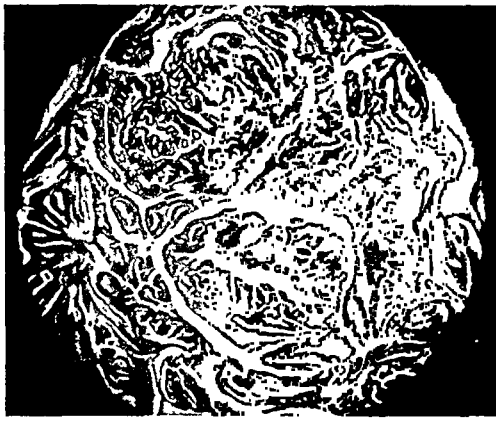


FIG. 4.—Case M. A. (M. G. H., East Surgical, No. 298127): Section shows a benign papilloma. There is no invasion, despite a 12-year history of nipple bleeding. (X120)

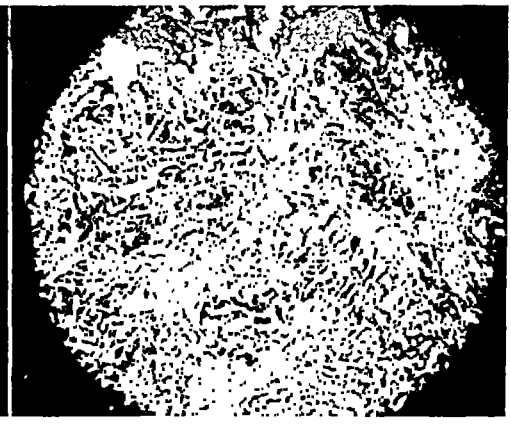


FIG. 5.—Case L. M. (M. G. H., West Surgical, No. 281571): A papillary adenocarcinoma with nipple discharge and a mass underlying the nipple. (X120)

Discharge from Hormonal Dysfunction.—The indications for inclusion of cases under this heading are not altogether satisfactory, since they rest on clinical grounds only. None of these seven patients was operated upon. There were no masses, cysts, nor areas of nodularity in any of these breasts. Three women had a milky discharge; three had a brownish or serosanguineous discharge; and one woman had a mucous discharge which ceased after the administration of ovarian extract. Mazer[63] and Lewis and Geschickter[56] have reported good results after estrogen therapy in a small group of women in whom breast bleeding occurred at the time of menopause. They postulate a lobular proliferation of epithelium (*i.e.*, adenosis) due to deranged hormonal physiology, and have clinical and experimental evidence in support. However, their therapy rests upon the clinical diagnosis of the morbid state in the mammary gland. In our experience, the clinical diagnosis in this age-group is not to be relied upon to this extent.

Nathanson[68] has demonstrated a definite relationship between galactorrhea and deficiency of the estrogenic hormone. The proliferative action of estrin on the epithelium of the cervix is well known. Our cases of galactorrhea warrant mention in this connection. The three women were multiparae, with badly lacerated, infected cervices. Two of them were given large amounts of estrin over a period of months, during which time the galactorrhea ceased. In one woman, a small, infiltrating carcinoma of the cervix was discovered one year after treatment was started. In the second patient, a biopsy of the cervix, ten weeks after treatment, showed "some growth of epithelial cells

between the columnar epithelium, and the basement membrane" which was regarded as a possible precancerous focus. It is suggested that a conservative attitude toward the administration of large amounts of estrin for the correction of this breast discharge is perhaps wise, particularly if there is other pathology in the breast or cervix.

Paget's Disease of the Nipple.—It is of course recognized that Paget's disease will often be attended by a discharge from the surface of the ulcerated nipple. However, a number of investigators, including Jacobeus,[44] Dunn,[24] and Muir,[67] have advanced the proposition that a carcinoma of the large ducts precedes and eventually causes the characteristic nipple changes. In such an event, it is logical that the intraductal growth might manifest its presence by nipple discharge, prior to the appearance of the "pagetoid" changes in the nipple.

From a number of instances of Paget's disease, two cases were found in which a nipple discharge antedated any observed alteration in the nipple. The discharge was bloody in one case, and "watery-yellow" in the second. Lepper and Baker[59] reported a bloody discharge in 7 of 11 intraductal carcinomata. Geschickter describes 25 cases of duct cancer composed of large "pagetoid" cells, seven of which manifested nipple discharge in the absence of nipple ulceration.

Inflammatory Cysts.—A diagnosis of inflammatory cyst had been made on three specimens. The patients were 31, 40, and 48 years old, respectively. All three presented a circumscribed mass in the central portion of the breast for which they had been referred to the Tumor Clinic. In addition some type of nipple discharge, varying from bloody to milky, was also present. On pathologic examination, isolated chronic cysts with smooth lining were found. The cyst walls showed pronounced inflammatory changes.

Fibrous Mastitis.—Two breasts in this series, which were removed because of bloody discharge, showed histologically a pronounced increase in breast stroma accompanied by apparent atrophy of the epithelial elements. A female, age 33, gave a history of breast pain for one year, and bloody nipple discharge for four months. Clinically, her breast was unremarkable. On section, it was dense, leathery, and firm. There were no cysts. Microscopically, a profound fibrous mastitis, with atrophy of epithelial structures, was seen.

A female, age 71, had had a milky nipple discharge, followed by a reddish-brown discharge for eight months. Her breast was small, firm, and the nipple was hard and inverted. Sections, studied microscopically, were comparable to the above case.

The elderly patient should probably be classified as an example of senile involution. A precocious involution may also be responsible for the changes in the breast of the younger woman. Chronic interstitial mastitis, which Ewing[26] describes as a variant of chronic mastitis, is not usually marked by this degree of epithelial atrophy.

It is of interest to note that the sign of nipple bleeding, so commonly asso-

ciated with hyperplastic epithelium, can also occur in a breast in which there is minimal epithelial activity.

Miscellaneous.—Under this heading are included six cases which have been under recent observation and in which the diagnosis has not been clearly established. With one exception, all of these patients are from 35 to 40 years of age. Three of them have had serosanguineous discharge, and three have had only a serous discharge. Two women in this group illustrate certain features of special interest:

Case 1.—B. D., No. 316809: H. M., female, age 36, had had a bloody discharge for three weeks. A minute mass could be felt just superior to the areolar margin. This mass had also been felt in another Tumor Clinic. Survey was urged but refused. Three months later the tumor was no longer present and no discharge had occurred.

It is probable that a bleeding duct papilloma was responsible. The tumor resulted from an accumulation of blood in a cystic dilatation of a duct. With cessation of bleeding, the small cysts collapsed. Fischer,[27] in 1931, cited an instance of a "phantom tumor of the breast" produced in this manner.

Case 2.—M. G. H., Unit No. 33065: M. S., female, age 17, had had bloody nipple discharge intermittently for one year, following trauma to the breast. On examination, the breast felt normal, and no discharge could be expressed. Transillumination was not carried out.

While trauma is a well-recognized cause of bloody nipple discharge the relationship is usually obvious—a hematoma is present, and bleeding ceases within two weeks after the trauma. Therefore, a number of authors lay stress upon repeated or continuous bleeding as opposed to a single, brief episode. Thus, it is improbable that trauma played a principal rôle in the last case (Case 2).

Diagnosis.—(A) Nature of the Discharge: A thick, inspissated discharge may come from inverted nipples. Microscopic examination is often necessary, in order to demonstrate the presence of blood, as Adair has emphasized, but is of no help in revealing the presence of malignant cells, according to Greenough.[34] The presence of blood is significant, but its absence cannot rule out a lesion dangerous to the patient. Diagnosis is practically established by the finding of a continuous milky, or a greenish yellow discharge, indicating respectively, galactorrhea or duct stasis.

(B) Source of Discharge: Three special diagnostic aids are employed for the detection of lesions associated with nipple discharge. The presence of a small lesion, such as a papilloma, is occasionally demonstrated by the positive pressure test, whereby pressure over a segment of the areola expresses the discharge from the nipple. Transillumination will distinguish between a solid tumor and a cyst containing clear fluid, and will often reveal impalpable papillomata which may be multiple. However, if the papilloma has not bled, it may escape detection, as the opacity seen on transillumination is usually due to the collection of blood around it. Recently, the value of contrast mammography has been acclaimed, especially by Hicken and his co-workers.[42] Our experience with the method has been limited to a few cases. The serious

tissue reactions which several groups of investigators have reported following the use of thorotrast for mammography, plus the possibilities of diagnostic error, tend to minimize its value.

Treatment.—The group of patients in whom both tumor and discharge are present arouse no controversy. The presence of the mass is an indication for surgery, independent of discharge. However, a bloody discharge should not stampede the surgeon into performing a radical mastectomy. In Hart's[40] series of 104 benign, intracystic papillomata, a radical mastectomy had been performed in 38 per cent. On the other hand, Miller and Lewis[65] found 27 malignant lesions in 40 breast tumors associated with nipple bleeding. Frozen section diagnosis of lesions associated with nipple discharge is sometimes difficult, because early or uncommon types of cancer may be encountered for the diagnosis of which permanent sections may be necessary.

The troublesome and dangerous problem is the discharging breast which, on examination, contains no mass. DaCosta[19] has said, "It is better that a woman lose her breast needlessly, than her life." One need offer no apology for performing many biopsies or even simple mastectomies in border-line cases wherein the clinical picture suggests the possibility of carcinoma, even though many such operations demonstrate a benign lesion. However, the psychic and cosmetic arguments against mastectomy are prominent in the minds of patients, and demand consideration. Three general alternatives present themselves.

(I) *Mastectomy.*—Cheatle[12] is a strong advocate of mastectomy when the discharge is bloody. Supporters of this policy argue that the undiscovered source of the discharge is probably a papilloma or Schimmelbusch's disease, both of which they regard as precancerous. Moreover, the first sign of an actual cancer may be nipple discharge.

(II) *Observation.*—Bloodgood[5] has stated that bleeding *per se* never justifies complete removal of the breast. Adair's recommendations are conservative. He has given up irradiation for this group of cases and awaits the appearance of a tumor unless transillumination reveals a papilloma. Geschickter, and others treat adenosis with large doses of estrin. Nodularity and bleeding often disappear. In favor of a waiting policy are the facts that impalpable cancer is rare, and discharge, even though bloody, not infrequently ceases spontaneously. Moreover, many surgeons do not regard this proliferative phase of cystic disease as precancerous.

(III) *Local Excision or Mastectomy.*—To many women, the idea of a mastectomy is intolerable, and in many cases of nipple discharge it is a radical procedure. Local surgery may often supplant the less desirable alternatives of observation or mastectomy. There are five groups of patients with nipple discharge and no tumor, in which the indications for surgery are definite, in our opinion:

(1) Nipple discharge with positive transillumination.
(2) Nipple discharge with positive pressure test.
(3) Nipple discharge with localized nodularity in the breast.
(4) Nipple bleeding after the menopause.
(5) Continued nipple bleeding of undetermined origin.

(1) *Nipple Discharge with Positive Transillumination.*—When transillumination demonstrates an area of opacity in one of the large ducts near the nipple, the probable diagnosis of papilloma may be made. Local excision of the offending duct is indicated. The ingenious suggestion of Babcock[4] appears to be the most satisfactory procedure for identifying the diseased duct in the operative field. Noting the duct orifice in the nipple whence the discharge comes, he threads the duct over the blunt end of a fine needle. An incision is made at the areola margin and the duct is distinguished by tilting the inserted needle. Multiple opacities may be visualized. Block excision of a breast segment or mastectomy may be required, depending on the extent and distribution of the papillomatous lesions.

(2) *Nipple Discharge with Positive Pressure Test.*—Occasionally, palpation and transillumination are negative, but pressure over a constant area within or near the areolar zone produces the discharge. A recent clinic patient had had amber-colored nipple discharge for one year, bloody on one occasion. She was able to cause the discharge by drawing a finger tip across the areola toward the nipple, along a constant axis. The discharge came from only one duct orifice. Palpation and transillumination were negative. In our opinion, excision of this duct should be undertaken.

(3) *Nipple Bleeding with Localized Nodularity in the Breast.*—Not infrequently, bloody nipple discharge occurs in a woman about 40 years of age, whose breast, on palpation, manifests a localized area of nodularity commonly felt in the upper outer quadrant. The remainder of the breast may be normal, or there may be diffuse "shottiness" in which one area stands out more prominently than the rest. Histologically, such an area is apt to present the picture of epithelial overgrowth. Twice in our experience, this clinical appearance of a benign lesion has masked the presence of an actual carcinoma in this site. It is our conviction that a biopsy should be obtained in all such cases. If hyperplastic epithelium is found, either a quadrant excision or mastectomy is proper.

(4) *Nipple Bleeding after the Menopause.*—In this situation, the psychic and cosmetic arguments against mastectomy are so attenuated, and the threat of cancer so real, that it is safer to adopt an arbitrary policy and advise simple mastectomy, unless it is possible that some definite local lesion can be identified.

(5) *Continued Nipple Bleeding of Undetermined Origin.*—The entire breast should be removed in those cases of continued nipple bleeding (*i.e.*, one month or more) in which no localized source of the bleeding is apparent.

Further aid in individualizing patients with a breast discharge as to surgery versus observation may be secured by a consideration of the following factors: (1) The type of discharge; (2) the duration of the discharge; (3) the age of the patient; (4) a family history of cancer; (5) the size of the breast; (6) the psychology of the patient; and (7) the question of adequate follow-up, essential to a program of observation.

SUMMARY AND CONCLUSION

(1) Sixty-seven cases of nipple discharge are reported. The discharge contained blood in 35 instances.

(2) Three lesions were responsible for about three-quarters of the cases—carcinoma, chronic cystic mastitis, and papilloma. The papilloma is a precancerous condition. Chronic cystic mastitis, with epithelial hyperplasia, is also to be regarded as precancerous.

(3) Twenty-four women had cancer. Twelve of them had a nonsanguineous discharge. In 11 women, discharge was the first warning of any disease in the breast. Four women had no mass in the breast at the time of their first examination.

(4) Contrary to common experience, chronic cystic mastitis was encountered more than twice as often as papilloma.

(5) The chief problem in this study is the discharging breast in which no mass is palpable. Such a breast must be suspected of harboring not only the precancerous conditions of a papilloma or chronic cystic mastitis with epithelial hyperplasia, but even an actual cancer.

(6) Treatment consists of local surgery or mastectomy. Radiation therapy has not proven to be of value. A definite number of cases require not operation, but observation; the surgeon, however, should try to make this latter group as small as possible, by consideration of all possible surgical indications. In this manner, important cancer-preventive surgery can be performed and the surgeon will occasionally be rewarded by the discovery of an early, impalpable cancer.

The author wishes to acknowledge with gratitude the advice and assistance of Drs. Grantley W. Taylor and William M. Shedden in the composition of this article.

REFERENCES

[1] Adair, F. E.: Sanguineous Discharge from the Nipple, and Its Significance in Relation to Cancer of the Breast. ANNALS OF SURGERY, 91, 197–209, 1930.

[2] Adair, F. E.: Personal communication.

[3] Auchincloss, H.: Cystic Disease of the Breast. Nelson's Loose-Leaf Surgery, Thomas Nelson & Sons, New York, 4, 58, 1931.

[4] Babcock, W. W.: A Simple Operation for the Discharging Nipple. Surgery, 4, 914-916, 1938.

[5] Bloodgood, J. C.: Benign Lesions of the Female Breast for Which Operation Is Not Indicated. J.A.M.A., 78, 859–863, 1922.

[6] *Idem:* The Changing Clinical Picture of Lesions of the Breast. Am. Jour. Med. Sci., 179, 27, 1930.

[7] *Idem:* Border-line Breast Tumors. Am. Jour. Cancer, 16, 103–176, 1932.

[8] *Idem:* Comedo Carcinoma (or Comedo Adenoma) of the Female Breast. Am. Jour. Cancer, 22, 842, 1934.

[9] Boyd, W.: Surgical Pathology. W. B. Saunders Co., Third Edition, Philadelphia and London, 1933.

[10] Cahill, J. A., and Caulfield, P. A.: The Possible Relationship of Chronic Cystic Mastitis to Malignancy. Southern Med. Jour., 31, 245–251, 1938.

[11] Campbell, O. J.: Relationship Between Cystic Disease of the Breast and Carcinoma. Arch. Surg., 28, 1001–1056, 1934.

[12] Cheatle, G. L.: Cysts and Papillomata of the Breast. Brit. Jour. Surg., 9, 235–241, 1921.
[13] *Idem:* Schimmelbusch's Disease of the Breast; and Dr. A. Lacassagne's Experiments on Mice. Brit. Jour. Surg., 22, 710–715, 1934–1935.
[14] Cheatle, G. L., and Cutler, M.: Tumor of the Breast. Arnold, London, 1931.
[15] Claye, A. M.: Lactation Associated with Bleeding. Brit. Med. Jour., 1, 665–666, 1934.
[16] Cutler, M.: Transillumination as an Aid to the Diagnosis of Breast Lesions. Surg., Gynec., and Obstet., 48, 721–729, 1929.
[17] *Idem:* Relationship of "Chronic Mastitis," Cysts and Papillomata to Cancer of the Breast. J.A.M.A., 99, 2152, 1932.
[18] *Idem:* A New Method for the Treatment of "Bleeding Nipple" by Radium Implantation. Am. Jour. Roentgenol., 31, 819–822, 1934.
[19] DaCosta, J. C.: Modern Surgery. W. B. Saunders, 10th Edition, 1931, Philadelphia and London.
[20] Davidoff, R. B., and Friedman, H. F : The Treatment of Discharge from the Nipple. New England Jour. Med., 216, 1072–1074, 1937.
[21] Deaver and McFarland: The Breast: Its Anomalies, Its Diseases and Their Treatment. P. Blakiston's Son and Co., Philadelphia, 1917.
[22] Dees, J. G., and Schmeisser, H. C.: Intracystic Papilloma and Papillocarcinoma of the Breast. South. M. J., 30, 690–696, 1937.
[23] Dickinson, G. K.: The Breast Physiologically and Pathologically Considered, with Relation to Bleeding from the Nipple. Am. Jour. Obstet. and Gynec., 3, 31–34, 1922.
[24] Dunn, J. S.: Invasion of Epidermis by Carcinoma. Jour. Pathol. and Bacteriol., 33, 297, 1930.
[25] Erdheim, S.: Über die Klinische Bedeutung und die pathologische Grundlage der sogenannten "blutenden Mamm." Arch. f. klin. Chir., 139, 366, 1926; also, Zentralb. f. Chir., 54, 131. 1927.
[26] Ewing, J.: Neoplastic Diseases. W. B. Saunders Co., Third Edition, Philadelphia and London, 1931.
[27] Fischer, C. F.: Tumors of the Breast Producing Discharge from the Nipple (Phantom Tumor of the Breast). West Virginia Med. Jour., 27, 201, 1931.
[28] Floyd, W. O., and Haggard, W. D.: A Study of 500 Breast Cases with End-results. Jour. Tennessee Med. Assn., 23, 24, 1930.
[29] Geschickter, C. F.: Mammary Tumors. Surgery, 3, 916–949, 1938.
[30] Geschickter, C. F.: Personal communication.
[31] Gilbert, P.: La radiotherapie des tumeurs vegetantes intracanaliculaires du sein. Medecine, 16, 470–478, 1935.
[32] Graham, R. R.: Some Aspects of the Pathology of Chronic Breast Lesions. Canad. Med. Assn. Jour., 14, 921–929, 1924.
[33] Greco, T.: Contributo all studio dell cosidetta "mammella sanguinante." Asp. Maggiore, 21, 425–429, 1933.
[34] Greenough, R. B.: Varying Degrees of Malignancy in Cancer of the Breast. Jour. Cancer Research, 9, 453–463, 1925.
[35] Greenough, R. B., and Simmons, C. C.: Papillary Cystadenomata of the Breast. ANNALS OF SURGERY, 45, 188–202, 1907.
[36] Gronwald, G.: Cancerous and Noncancerous Origin of Bleeding from the Nipple. Beitr. z. klin. Chir., 144, 336–384, 1928.
[37] Gross, S. W.: Sarcoma of the Female Breast; Based upon a Study of One Hundred and Fifty-six Cases. Am. Jour. Med. Sci., New Series, 94, 17, 1887.
[38] Handley, W. S.: Hunterian Lecture on the Papilloma and Its Menace. Journal-Lancet, 1, 1383, 1930.
[39] Harpoth, Harold: Et tilfaelde af papilloma intracanaliculare mammae. Vgesk F. Laeger, 93, 183, 1931.

[40] Hart, D.: Intracystic Papillomatous Tumors of the Breast, Benign and Malignant. Arch. Surg., 14, 793–835, 1927.

[41] Harvey, S. C.: "Chronic Cystic Mastitis" as a Physiologic Aberration, and Its Significance in the Diagnosis and Treatment of Tumors of the Breast. Yale Jour. Biol. and Med., 7, 521–532, 1934–1935.

[42] Hicken, N. F., Best, R. R., and Hunt, H. B.: Discharges from the Nipple—Their Clinical Significance and Mammographic Interpretation. Arch. Surg., 35, 1079–1094, 1937.

[43] Ingleby, H.: Hemorrhage from the Nipple Due to a Benign Intraductal Polyp. Lancet, 2, 1206, 1933.

[44] Jacobeus, H. C.: Pagetsche Krankheit und ihr Verhältnis zum Milchdrüsenkarzinom. Virchows Arch. f. path. Anat. u. Physiol., 178, 124–142, 1904.

[45] Judd, E. S.: Intracanalicular Papilloma of the Breast. Lancet, 37, 141–144, 1917.

[46] Kaump, D. H., and Mendes-Ferreira, A. E.: Papillomas of the Breast. Jour. Lab. and Clin. Med., 22, 681–686, 1937.

[47] Kilgore, A. R.: Chronic Cystic Mastitis: Its Relation to Cancer of the Breast. Calif. and Western Med., 29, 289, 1928.

[48] *Idem:* Discharge from the Nipple. Lewis: Practice of Surgery, 5, 15. W. F. Prior Co., Inc., Hagerstown, Maryland, 1930.

[49] Klages, F.: Die "blutende Mamma" in ihrer Beziehung zum Brustdrüsenkrebs. Arch. f. klin. Chir., 168, 743–761, 1932.

[50] Knoflach, I. G., and Urban, K.: Zue Pathologie und therapie der blutenden mamma. Arch. f. klin. Chir., 150, 355, 1928.

[51] Kon, Y.: Zue Anatomie und Klinik der "blutenden Mamma." Mitt. ü. allg. Path. Anat., 8, 231–246, 1934.

[52] Kondo, H.: A Case of Hemorrhagic Breasts Complicating Pregnancy. Jap. Jour. Obstet. and Gynec., 14, 233, 1931.

[53] Lee, B. J.: A Case of Carcinoma of the Breast Illustrating the Significance of Bleeding Nipple. Surg. Clin. N. Amer., 13, 421–422, 1933.

[54] *Idem:* End-Results in Treatment of Cancer of Breast by Radical Surgery Combined with Preoperative and Postoperative Irradiation. Amer. Jour. Surg., 20, 405–443, 1933.

[55] Lewis, D.: Bleeding Nipples. Surg., Gynec., and Obstet., 22, 666, 1916.

[56] Lewis, D., and Geschickter, C. F.: Ovarian Hormones in Relation to Chronic Cystic Mastitis. Amer. Jour. Surg., 24, 280–304, 1934.

[57] *Idem:* Comedo Carcinoma of the Breast. Arch. Surg., 36, 225–244, 1938.

[58] *Idem:* The Relationship of Chronic Cystic Mastitis to Carcinoma of the Breast. Surg., Gynec., and Obstet., 66, 300, 1938.

[59] Lepper, E. H., Baker, A. H., and Hartog, H.: A Series of Cases of Duct Papilloma of the Breast. Lancet, 2, 1031–1033, 1933.

[60] Lepper, E. H., and Baker, A. H.: Diffuse Intraductal Carcinoma of the Breast. Brit. Jour. Surg., 22, 415–423, 1934–1935.

[61] MacCarthy, W. B., and Mensing, E. H.: The Relation Between Chronic Cystic Mastitis and Carcinoma of the Breast. St. Paul Med. Jour., 18, 164–167, 1916.

[62] MacNeal, W. G.: Chronic Cystic Mastitis. Surg. Clin. N. Amer., 12, 523, 1932.

[63] Mazer, C.: Endocrine Glands in Relation to Abnormal Breast Hyperplasias—with Particular Reference to the Associated Nipple Bleeding and Its Treatment. Med. Rec., 140, 417–420, 476–479, 1934.

[64] Mazer, C., and Israel, S. L.: The Optimal Dosage of Estrogens. J.A.M.A., 108, 163, 1937.

[65] Miller, E. M, and Lewis, D.: The Significance of a Serohemorrhagic or Hemorrhagic Discharge from the Nipple. J.A.M.A., 81, 1651–1657, 1923.

[66] Miller, E. M.: Lesions of the Breast Associated with a Discharging Nipple. Surg. Clin. N. Amer., 4, 757, 1924.

[67] Muir, R.: Pathogenesis of Paget's Disease of the Nipple and Associated Lesions. Brit. Jour. Surg., 22, 728–737, 1935.
[68] Nathanson, I. T.: Personal communication.
[69] Oliver, R. L., and Major, R. C.: Cyclomastopathy: A Physiopathologic Conception of Some Benign Breast Tumors with an Analysis of 400 cases. Am. Jour. Cancer, 21, 1–85, 1934.
[70] Patey, D. H.: Chronic Cystic Mastitis and Carcinoma. Internat. Abst. of Surgery, 68, 575–579, June, 1939.
[71] Pribram, B. O.: Die pathologische Bedeutung der blutenden Mamma. Med. Klin., 27, 1853, 1931.
[72] Reis, R. A., and Mesirow, S. D.: Studies in the Evaluation of Mammography. J.A.M.A., 110, 1900–1905, 1938.
[73] Robles, A., and Banno, S.: La mamella sanguinante. Minerva Med., 1, 6, 1932.
[74] Romano, S. A., and McFetridge, E. M.: The Limitations and Dangers of Mammography by Contrast Mediums. J.A.M.A., 110, 1905–1910, 1938.
[75] Sanchelli, E. C.: Papilloma of the Breast. Med. Rec., 146, 111–112, 1937.
[76] Schimmelbusch, C.: Das Fibroadenom der Mamma. Arch. f. klin. Chir., 44, 102–117, 1892.
[77] Sistrunk, W. E.: Surgical Aspects of Benign Lesions of the Breast. New Orleans Med. and Surg. Jour., 75, 47–57, 1922.
[78] Sowers, B. F., and Masson, J. C.: Mastitis Following Use of Thorium Dioxide: Report of Case. Proc. Staff Meet. Mayo Clin. 12, 528–531, 1937.
[79] Stowers, J. E.: The Significance of Bleeding or Discharge from the Nipple. Surg., Gynec., and Obstet., 61, 537–543, 1935.
[80] Taylor, H. C.: Relationship of Chronic Mastitis to Certain Hormones of the Ovary and Pituitary and to Coincident Gynecologic Lesions. Part I, Theoretical Considerations and Histologic Studies. Surg., Gynec., and Obstet., 62, 129–148, 1936. Part II, Surg., Gynec., and Obstet., 62, 562–584, 1936.
[81] Tapie, P.: The Bleeding Nipple. Med. Jour. and Rec., 121, 537–538, 1925.
[82] Tod, M. C., and Dawson, E. K.: Diagnosis and Treatment of Doubtful Mammary Tumors. Lancet, 2, 1041–1045, 1934.
[83] Wainwright, J M.: The Treatment of the Bleeding Breast. Am. Jour. Cancer, 19, 339–352, 1933.
[84] Warren, S.: "Chronic Mastitis" and Carcinoma of the Breast. Surg., Gynec., and Obstet., 71, 257–273, 1940.
[85] Wolpers, C.: Die Blutende Mamma. Arch. f. klin. Chir., 174, 447–474, 1933.

SURGICAL TREATMENT OF TUMORS OF THE MEDIASTINUM*

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THE MEDIASTINUM harbors an extraordinary variety of tumors and tumor-like lesions. These include the dermoid cysts and teratomata, the cysts of endodermal and mesodermal origin, the cystic lymphangiomata, and the echinococcus cysts; the connective tissue tumors including the fibromata, lipomata, leiomyomata, xanthomata, chondromata, chondromyxomata and chondromyxosarcomata; the neurogenic tumors including the neurofibromata, ganglioneuromata, neuroblastomata and neuro-epitheliomata; the primary tumors of the thymus including the benign and malignant thymomata; the primary tumors of the mediastinal lymph nodes including lymphosarcomata, Hodgkin's disease and endotheliomata; the primary and secondary sarcomata of the mediastinum; the rather heterogenous group of primary and metastatic carcinomata of the mediastinum; and, lastly, the intrathoracic goiters. These form unusually interesting groups of pathologic lesions, to each of which much more time could profitably be devoted. Their surgical treatment is a large subject which cannot properly be discussed briefly; and in a short résumé of the surgical procedures employed one can only make some broad and general statements, to which, no doubt, many may find exceptions from their own experience.

Except to name the varied tumors of the mediastinum as above mentioned, their pathology will not be further considered. Symptomatically, all tumors of the mediastinum give rise to somewhat similar clinical manifestations. These may be grouped as general symptoms because they are common to all tumors and include pain in the chest, cough, dyspnea and cyanosis; and local symptoms caused by pressure upon or involvement of structures in the immediate neighborhood of the lesion. These latter give some indication of the location of the lesion within the mediastinum; and since certain tumors have a predilection for certain locations, give us also some indication of the nature of the lesion. The occurrence of Horner's syndrome, for example, suggests not only a lesion of the posterior mediastinum, but one arising from the paravertebral sympathetic chain. It is to be noted, however, that mediastinal tumors may fail to give rise to noteworthy symptoms. With the more frequent use of routine roentgenologic examinations of the chest, an increasing number of individuals are coming under observation who have mediastinal tumors but who fail to have symptoms referable to them.

* Read before the New York Surgical Society, January 24, 1940. Submitted for publication December 29, 1939.

In the diagnosis and differential diagnosis of mediastinal tumors all the available resources of the internist, roentgenologist, bronchoscopist and surgeon often are necessary. Often physical, roentgenologic, bronchoscopic, sputum and other examinations will serve, in some cases, not only to establish the presence and location of a lesion but also its pathologic nature. In other cases, the application of these diagnostic measures succeeds in establishing the presence of a lesion, but fails to indicate its nature. In some of these, and especially those near the thoracic wall, an aspiration biopsy may serve to establish the pathologic diagnosis; in others, the removal of an accessible involved lymph node; in still others the response of a lesion to a controlled dose of roentgenotherapy. But there will remain, in any series, a number of cases in which all diagnostic measures now available to us fail to establish the pathologic nature of the tumor. In these, nothing short of an exploratory thoracotomy will establish it. Certainly, one of the handicaps to more intelligent treatment of mediastinal tumors lies in our diagnostic limitations.

Surgical Indications.—It has been our experience that the dermoid cysts and nonmalignant teratomata, the various other mediastinal cysts, the intrathoracic goiters, the benign connective tissue tumors, including those derived from cartilage, the benign tumors of neurogenic origin, the benign tumors of the thymus and some of the sarcomata lend themselves to surgical removal; while, thus far in our experience, the primary malignant tumors of the mediastinal lymph nodes (lymphosarcoma, Hodgkin's disease, *etc.*), the malignant teratomata, the malignant thymomata and the various other mediastinal carcinomata have proven unsatisfactory from the viewpoint of surgery. While a number of such cases have been subjected to surgery, exploration has always shown an extent of the disease beyond the possibilities of surgical eradication. Roentgenotherapy in these has served to relieve the symptoms and prolong life, particularly in patients with Hodgkin's disease and lymphosarcoma, but in our hands has not proven very helpful in other lesions within the mediastinum.

If, then, a positive diagnosis can be made of the various benign tumors and cysts which I have enumerated, surgical removal is believed to be the treatment of choice. If, on the other hand, a positive diagnosis can be made of the malignant lesions I have just mentioned, surgery has not, as a rule, been attempted. In cases in which the diagnosis cannot be established and which may be benign or malignant, certain criteria have been used in deciding for or against operation. Most important, in our hands, in deciding for operation is the character of the shadow seen in the roentgenogram. A clearly defined, circumscribed shadow is most often associated with a benign lesion although it does not rule out a ganglioneuroma or teratoma which has undergone malignant change, nor certain sarcomata, nor lesions other than tumor, as mediastinal abscess, nonpulsating aneurysms, *etc.*

In reviewing our experience, I find that there is a great difference of opinion with respect to the treatment of tumors without, or with insignificant, symptoms with respect to the roentgenotherapy of mediastinal tumors, and

with respect to the size of tumors which may be attacked surgically. These aspects of surgical indications deserve, perhaps, a brief discussion.

There seems little doubt that various benign mediastinal tumors may fail to provoke pronounced symptoms over long periods of time. The occasional finding, in an elderly individual, of a tumor which, because of its nature, must have originated early in life, even suggests that a person may carry a tumor throughout life without serious impairment of health. But our experience and that of others, as reported in the literature, is that this is exceptional rather than common. The early or late appearance of symptoms in any given case is dependent upon the relation of the tumor to important mediastinal structures. The general symptoms of pain, cough, dyspnea and cyanosis and the local pressure symptoms manifested, for example, by Horner's syndrome, are the results of compression or involvement of important blood vessels, nerves, trachea, bronchi or esophagus within the mediastinum. A tumor may be so placed with respect to these structures as not to involve them; and symptoms may be inconspicuous or absent. Again, a small tumor, placed so as to compress a major bronchus, may cause the most intense symptoms, while another tumor of unbelievable size may cause only moderate symptoms. There is some evidence to show that some benign tumors undergo a slow and continuous growth, as might be expected; while others, having reached a certain size, become, for a considerable time, quiescent, or grow so slowly that their growth cannot be demonstrated roentgenographically over several years. These presumably quiescent tumors may at any time again begin to grow and this secondary activity may, and not uncommonly does, indicate a malignant change in a previously benign tumor. In general, I think it may be said that the tumors without symptoms, or with insignificant symptoms, sooner or later provoke symptoms because of simple enlargement or malignant degeneration. A study of our cases, and a review of the literature, show the danger to the individual who harbors a benign tumor. In a review of more than 150 dermoid cysts I find that 46 remained untreated; all died of the disease; among 13 cases of dermoid cyst and teratoma in our own series, five had undergone malignant change at the time they came under our observation. Of 28 cases of lipoma of the mediastinum, 13 were not treated and all died; and in seven death was directly due to the lesion. In 18 cases of fibroma of the mediastinum, 13 were not treated and all died; in five, the tumor was removed and all recovered. I could enlarge upon data such as these. The point I wish to make is that the lack of prominent symptoms in a patient with a mediastinal tumor is, to the individual, a fortunate circumstance, but does not necessarily imply that the lesion is quiescent, or that it may not undergo malignant degeneration, or that it may not eventually cause death if not removed. It would seem wise, at least, to seriously consider surgery in this group of cases.

With respect to the roentgenotherapy of tumors of the mediastinum, it has been our experience that a majority of patients referred to us have already had deep roentgenotherapy for their lesions. The opinion seems

to be prevalent that roentgenotherapy may achieve satisfactory results in mediastinal tumors; and if it fails to do so, surgery may then be considered. I would suggest that this attitude be reversed; that upon the discovery of a mediastinal tumor, the surgeon, experienced in this field, should first be consulted; and not until he has concluded that surgery is inadvisable should roentgenotherapy be undertaken. It has been found, as I have indicated, that certain benign tumors and a few of the malignant tumors of the mediastinum are amenable to surgical removal. These, in general, fail to respond to roentgenotherapy. Not only does roentgenotherapy fail to reduce their size but it may also fail to prevent their malignant degeneration. It may and does provoke massive adhesions in the mediastinum which make later surgical removal more difficult and dangerous. In these cases roentgenotherapy is not only a wasted effort but one which may actually do harm.

The mere size of intrathoracic tumors has, on occasion, deterred the physician from contemplating the possibility of surgery. Reading the reports in the literature, one comes across cases of large tumors which are frequently mediastinal in origin. They have died from mediastinal compression, and the autopsy records the presence of a large mass unattached to any vital structure and easily removable. Some authors, in their comments upon such cases, have expressed regret that they had not considered the possibility of surgery. Our small experience with large tumors indicates that they may be removed. The duration of symptoms, the finding of a circumscribed shadow, and the fact that the patient has not long since succumbed to the condition, implies that the lesion is benign and has not involved vital structures within the mediastinum. Their removal is a mechanical problem which may indeed be difficult but which, with our present methods of anesthesia, is not impossible.

Operative Technic.—Perhaps only three procedures in the operative treatment of mediastinal tumors require comment. These are: (1) The choice of anesthesia. (2) The thoracic approach to the lesion. (3) The closure of the thoracic wound.

(1) After trying various methods, I have found the intratracheal method of anesthesia uniformly the most satisfactory. It relieves the surgeon of the fear of open pneumothorax; it permits, even, the wide opening of both pleural cavities if this becomes necessary during the course of the removal of the tumor. If the anesthetic is administered by a skilled anesthetist, anesthesia is, generally, smooth and satisfactory. A variety of anesthetic agents may be employed with this method. We have found ether and oxygen very satisfactory; also nitrous oxide-oxygen combined with ether. Most satisfactory of all, I think, is cyclopropane administered through an intratracheal tube; and this has been the anesthetic of choice in recent cases.

(2) The location of the mediastinal tumor determines the thoracic approach. Generally speaking, three operative approaches will be applicable in the majority of lesions. The small to moderately large anterior mediastinal tumors may be approached by an anterior T-shaped incision, the vertical leg of the T being placed parallel with and over an appropriate rib, the horizontal

leg of the T parallel with and over the lateral border of the sternum. A single rib with its costal cartilage is resected subperiosteally. The costal cartilage immediately above and below is divided at its sternal junction. With the pleura opened, and a rib separator properly placed, a large triangular opening is secured, the base at the sternum, the apex at the lateral thoracic wall.

For the upper posterior mediastinal tumors, a posterior approach along the spine with the retraction of the scapula and with the resection of sufficiently long segments of an appropriate number of ribs gives an exposure of the posterior mediastinum sufficiently large to remove all but the very large tumors. For the large tumors which have extended far into one or both pleural cavities, a long incision encircling the hemithorax, with or without the resection of a single rib, is to be preferred.

(3) The importance of the closure of the thoracic wound, after the operation within the thorax has been completed, cannot be overemphasized. Because of physiologic considerations, the closure should be air-tight, so as to prevent the occurrence of a "sucking" pneumothorax, and should be secure, so as to prevent subsequent reopening of the wound. If there has been no soiling during the procedure, closure should be complete and without drainage. Should an effusion occur after operation, this had better be treated by repeated aspirations than by primary drainage in anticipation of its occurrence. If definite soiling has taken place during the operation, the thoracic wound should, nevertheless, be closed completely and drainage, if thought necessary, established by the air-tight suction method at a distance from the wound.

In the immediate postoperative course, the oxygen tent has been found very useful and is regularly employed. The occurrence of an effusion postoperatively is common, and should be recognized early and treated as has been indicated.

It may be of interst to relate our experience at the New York Hospital, with reference to the mediastinal conditions which have been admitted to our medical and surgical wards. This experience demonstrates the great variety of mediastinal conditions which may be encountered in a general hospital, their nature, and, with reference to tumors, our limitations in their treatment. I have added to this number a few cases from my Baltimore and Cincinnati experiences, of which I have accurate records.

An examination of our medical and surgical records shows that, between September, 1932, and November, 1939, 199 patients with diseases of the mediastinum have been admitted to the wards of the New York Hospital. Of this number, 54 cases represent conditions other than tumor, and include five cases of acute mediastinal emphysema, 20 cases of acute or subacute pyogenic mediastinitis, seven cases of tuberculous mediastinitis, 16 cases of tuberculous mediastinal lymphadenitis, and six cases of nontuberculous mediastinal lymphadenitis.

One hundred forty-five of the 199 cases are examples of mediastinal tumor or tumor-like conditions. These may be classified as follows:

(I) Forty-seven were classified as primary malignant disease of the mediastinal lymph nodes. Of these, 29 were diagnosed as Hodgkin's disease and 18 as lymphosarcoma. In about 25 of the cases, the diagnosis was established by biopsy; in the remainder, the diagnosis was made by physical and roentgenologic examination, and the response to roentgenotherapy.

(II) Sixty were classified as primary and secondary malignant disease of the mediastinum. Of these, 31 were diagnosed as malignant disease of the mediastinum secondary to cancer of the lung and the bronchi; and 12 as malignant disease secondary to other malignant conditions. The remaining 17 were primary malignant tumors of the mediastinum and include three cases of superior sulcus tumor (carcinoma), three of liposarcoma, three of neurogenic sarcoma, one of apical fibrosarcoma, five of malignant teratoma, and two of malignant thymoma. The question of surgery arose only in these 17 cases.

(III) Thirty-nine were clasified as benign tumors of the mediastinum. In 17 cases in this group, the diagnosis has not been verified. Of the 22 verified cases, five were diagnosed as dermoid cysts, five chondromata or chondromyxomata, three thymomata, five neurogenic tumors, and one each as a xanthoma, lipoma, glioblastoma and epithelial cyst.

Surgical treatment in the above three groups of mediastinal tumors was considered possible only in the 17 primary malignant tumors in Group (II), and in the benign tumors in Group (III).

An examination of the 17 primary malignant tumors shows that the two malignant thymomata were clearly inoperable. Of the remaining 15 cases, surgical exploration was carried out in 12. In six of the 12 cases subjected to operation, the lesion proved to be inoperable, while in the remaining six cases the tumor was removed. Following operation there were two postoperative deaths, a mortality rate for surgical exploration of 16.6 per cent, and a mortality rate following tumor removal of 33 1/3 per cent. Of the four patients who survived tumor removal, one died about a year after operation from recurrence of the disease, while three are living—two of whom are living more than two years. There are no five-year survivals in this group so far.

Of the 39 cases diagnosed as benign tumors, operation was performed in 17, and resulted in the removal of the tumor in 16. Following operation there were three postoperative deaths. One death followed removal of a dermoid cyst, one death followed the removal of a large chondromyxoma, and one death followed the removal of a neurofibroma. A fourth death occurred during the infiltration of the thoracic wall with novocain, and before any incision had been made. If this case is excluded, the postoperative mortality in tumor removals is 18.7 per cent. Of the 13 patients who recovered, 12 are living and well. One patient operated upon for a benign chondroma later developed recurrences and metastases from which eventually she died.

SUMMARY AND CONCLUSIONS

A summary of this experience brings out the following points:

(1) In a series of 107 cases of malignant disease of the mediastinum, which includes Hodgkin's disease, lymphosarcoma and primary and secondary carcinoma and sarcoma, only 15, or 14 per cent, could be considered as favorable for surgical treatment. But, if the primary malignant tumors only are considered, surgery appeared possible in 15 of the 17 cases observed and was undertaken in 12 cases. In one-half of these cases it was possible to remove the tumor. The experience suggests that with earlier diagnosis and earlier surgical intervention a greater number of the primary malignant tumors of the mediastinum may come within the field of surgery.

(2) In a series of 39 cases of proven or presumed benign tumors of the mediastinum, a surgical operation was performed in but 17, or 43.5 per cent. In 16 of the 17 cases, the tumor was removed, and of 13 cases which survived operation, 12 are at present well. In one case, operation was abandoned because of the poor condition of the patient. It is of interest to inquire why a higher percentage of supposed benign lesions was not subjected to operation. An examination of the records of the 21 cases not subjected to operation shows that in five, surgical opinion regarding operation was not requested, and the outcome is unknown. Five entered the hospital late in the disease, with advanced symptoms which precluded operation, and died in the hospital or at home. In two, autopsies were obtained and showed neurogenic tumors. Eight patients refused operation. Of these, two have been followed and are now living; one was followed and died at home; two were followed two years, then lost; and three could not be followed. Of the remaining three cases, one was considered too old and feeble for operation, and in two, symptoms were so mild that operation could not be agreed upon. The last two are being followed. In view of the surgical results obtained, it is our opinion that a larger percentage of the benign, or presumably benign, tumors should be subjected to operation.

I am indebted to Doctor DuBois for permission to study the records of patients with mediastinal conditions who have been admitted to the medical wards of the New York Hospital.

HETEROTOPIC PANCREATIC TISSUE PRODUCING PYLORIC OBSTRUCTION

A REVIEW AND CASE REPORT

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UNTIL June, 1939, heterotopic pancreatic tissue has been reported in the literature approximately 340 times. Beaver,[1] in 1933, states that in complete routine autopsies this condition is found more frequently than statistics would indicate.

The majority of these cases have been asymptomatic. The fundamental cause of symptoms has been interference with the normal intestinal motility. Local spasm and muscle hypertrophy and contraction have been characteristic of these lesions in the stomach, duodenum, and upper jejunum; whereas, intussusception has been found entirely in the small bowel where an aberrant pancreas has frequently been associated with diverticula.

Heterotopic pancreatic tissue is of special interest to the surgeon because it may be confused with malignancy and healed or active peptic ulcer. Cross section of the tissue may reveal its identity. Frozen-section at the time of operation reveals its true character.

Statistical Review.—Poppi,[15] in 1935, presented interesting observations based upon 300 cases. The frequency of heterotopic pancreatic tissue was considered (Table I). The anatomic site and frequency of heterotopic pancreatic tissue was reported as follows: Stomach, 31.46 per cent; duodenum, 31.83 per cent; jejunum, 21.7 per cent; ileum, 9.36 per cent; mesentery, *etc.*, 3 37 per cent; biliary tract, 4.49 per cent; spleen, 0.74 per cent. Other sites mentioned in the literature were the umbilicus, appendix, and a dermoid cyst of the mediastinum.

TABLE I

FREQUENCY OF HETEROTOPIC PANCREATIC TISSUE IN CONSECUTIVE AUTOPSIES

Pathologist	No of Necropsies	No of Cases Found	Percentage
Feyrter	1,100	25	2 2
Katsurada	329	6	1 8
Kremer	467	6	1 2
Letuelle	180	10	3 0
Mouchet	200	5	2 5
Opie	1,800	10	0 55
Average Percentage			1 875

Etiology.—There are two general theories advanced to explain the occurrence of heterotopic pancreatic tissue. The first, proposed by Zenker[23] and later by Warthin,[21] advances the belief that during the outgrowth of the ventral pancreatic bud, a portion is carried away to its new position by em-

Submitted for publication October 10, 1939.

bryonic tissue development. The second theory, proposed by Taylor,[18] advances the belief that the condition is one of an atavistic tendency, since, in some of the lower animals, the pancreas is normally a divided organ which is found throughout the intestinal tract.

Histology.—In the majority of the reported cases, the heterotopic mass was composed of normal pancreatic cells and a definite duct system which apparently was functioning in a normal manner. Approximately one-third of the cases contained islets of Langerhans. Heterotopic pancreatic tissue has been reported to have been found in varying dimensions, ranging from those of microscopic proportions to that reported by Holzweisig,[12] which measured 6x3.5x1 cm.

The investigations of Delhougne[8] are of practical interest. In the 46 cases that he presented, the site of the heterotopic pancreatic tissue in the bowel wall was as follows: Submucosa, 45.5 per cent; intramuscular, 25.1 per cent; subserosal, 15.1 per cent; and in all of these layers, 14.2 per cent. It is evident that, in approximately 60 per cent of the cases, the mass may be discovered only by careful palpation of the bowel wall.

All pathologic changes that have occurred in the normal gland have been reported in the heterotopic gland tissue. Chronic inflammation has been commonly found. Acute necrosis, malignancy and ulceration have been reported.

Symptoms.—There have been no characteristic symptoms relative to the presence of heterotopic pancreatic tissue. Pain that has localized in the right upper quadrant or in the epigastrium was the most frequent complaint. The medical histories have resembled those of gastroduodenal ulcer, cholecystitis or appendicitis on one hand, and the obstructive signs of pyloric stenosis or intussusception of the intestine on the other. Poppi reviewed 43 such cases and found that in 39.53 per cent a clinical diagnosis of gastroduodenal ulcer had been made.

TABLE II

HETEROTOPIC PANCREAS IN TISSUE CAUSING INTESTINAL SPASM

Author	Reference	Site of Pancreatic Tissue*	Clinical Signs, Diagnosis, Etc.
1. Alessandri	Ann. Stal. di chir., p. 1. 1928.	Duodenum	Cholecystitis
2. Balognesi	Quoted by Poppi.	Duodenum	X-ray: Pyloroduodenal ulcer
3. Cigada, No. 2.	Atti i Mem. Soc. Lomb. di Chir., 14, 1159, 1934.	Duodenum	Gastric ulcer. Duodenitis
4. Cogniaux, No. 1.	Arch. franco-belges de chir.,	Stomach	Pyloric ulcer
5. Cogniaux, No. 2.	p. 307, 1928.	Duodenum	Pyloric ulcer
6. Gibson	Med. Rec., p. 426, 1912.	Stomach	Emesis. Cholecystitis
7. Gosset, Lowei and Bertrand	Bull. Me n. Soc. de Paris, 8. 860, 1923.	Duodenum	Duodenal ulcer
8. Griep	Med. Klin., p. 877, 1920.	Stomach	Gastric symptoms; X-ray: Hour-glass stomach
9. Gruber	Quoted by Poppi.	Stomach	Emesis
10. Hilarowicz	Zentralbl. f. Chir., p. 1610, 1927.	Stomach	X-ray; Duodenal ulcer
11. Leriche	Lyon Chir., 2, p. 242, 1929.	Diverticulum of stomach	X-ray: Ulcer of pylorus
12. Lesne and Coffin	Bull. Soc. de pediat. de Paris, p. 636, 1925.	Pylorus	Projectile vomiting
13. Letulle and Vinoj	Soc. Anat. Paris, 1921.	Stomach	Gastric symptoms
14. Nova	Atti d. Soc. lomb. di Chir., February, 1933.	Jejunum	Duodenal ulcer syndrome

TABLE II (*Continued*)

	Author	Reference	Site of Pancreatic Tissue*	Clinical Signs, Diagnosis Etc.
15	Pignatti	Atti Soc Ital di Chir., October, 1927	Jejunum	Duodenal ulcer
16	Pohle	Zentralbl f Chir., 9, 1004, 1933	Duodenum	X-ray Duodenal ulcer
17.	Puhl	Deutsch Zeitschr f Chir., 239, 624, 1933.	Jejunum	Gastric ulcer
18	Razeman and Vander Dorp	Arch d mal de l'appar digestif., p 300, 1931.	Duodenum	Duodenal ulcer
19	Ritter	Bruns' Beitr., p 157, 1921.	Stomach	Pyloric ulcer
20	Roux-Berger	Bull Mem Soc de Paris, p. 890, 1923	Duodenum	Duodenopyloric ulcer
21	Schmeiden and Sebening	Arch. f. Klin Chir., p 384, 1927	Duodenum	Duodenal ulcer
22	Tenacerco and Barbillian	Bull et Mem Soc Nat de Chir., 1932	Pylorus	Gastric ulcer
23	Wertheimer	Bull et Mem Soc Nat de Chir., 6, 1933.	*Antrum of* stomach	*Vomiting, indigestion*

* In the above cases no lesion except the heterotopic tissue was found

Table II presents those cases of Poppi's series which demonstrate symptoms that I have interpreted as having been produced by local spasm of the intestinal wall. In each case the heterotopic tissue alone was found to produce the complaints.

Table III presents all discoverable cases of pyloric stenosis which has been secondary to the presence of heterotopic pancreatic tissue. The obstruction has been the result of muscle hypertrophy and contraction, which resembled

TABLE III

PYLORIC OBSTRUCTION AND HETEROTOPIC PANCREATIC TISSUE

Author	Year Reported	Site of Pancreatic Tissue	X-ray Report	Pathologic and Operative Report
Branch and Gross	1935	Pylorus	Defect of pylorus 50% residue	1 cm mass in pylorus
Cecchini, S	1886	Pylorus	?	Chronic inflammation of pancreatic tissue *Marked hypertrophy of gastric muscle* Compression of pylorus and duodenum
Choisser	1925	Duodenum	?	Hypertrophy of muscle
Cohen	1922	Pylorus	Defect of pylorus Distended duodenum 6-hr. residue	Hickory nut sized tumor, considerable narrowing of lumen, superficial ulceration
Danzis	1938	Duodenum	Pyloric obstruction and duodenal ulcer 40% residue	Retracted pylorus, tumor 1 cm in diameter
Delhaugne F (1) (2) (3)	1924	Pylorus Stomach		Nut-sized tumor, chronic thickening of muscle 1 cm. in size, in pylorus, hypertrophy muscle Hypertrophy of muscle
Gruber, Herle and Roth	1929	Pylorus		Stenosis of pylorus
Gutman and Thalheimer	1929	Duodenum		Stenosis of pylorus
Hedry	1924			Kronen sized tumor in anterior wall, infected, hypertrophy of muscle, stenosis, admitting tip of finger
Munch	1924	Pylorus	5½-hr residue	Benign pyloric stenosis
Raymer and Masson	1909	Pylorus		Nodule size of pea, pyloric stenosis
Simpson	1929	Pylorus	Duodenal spasm	Hypertrophy of muscularis
Thorel	1903			Hypertrophy of muscle
Tschudi, E	1931	Duodenum	Irregular duodenal bulk stenosis	Pancreatic tissue in submucosa Pylorus admits tip of finger
Weishaupt	1917	Duodenum		Pyloric stenosis

that found in cases of long-standing duodenal ulcer, the so-called congenital pyloric stenosis in the infant and adult, and the contracted rectal sphincter. The case herewith reported falls in the group considered in Table III.

Case Report.—Mrs. C. S., white, female, age 45, was referred by Drs. J. L. Siefert and H. Kullman, who had made a diagnosis of pyloric obstruction and cholecystic disease. The patient complained of having had periodic attacks of "gaseous indigestion" for the last 15 years. She had found that certain foods provoked these attacks, and that sodium bicarbonate and the prone position relieved them. The pain had always been crampy in character and had radiated both around the right costal margin and directly through to the back. Vomiting and headaches were occasionally present. At first, these attacks were mild and occurred at long intervals but they gradually became more frequent and more severe. During the previous three months the attacks had been so severe as to confine her to bed for one or two days.

The past history revealed that she had had measles and an attack of "jaundice" during childhood.

Pertinent findings upon examination revealed only obesity and slight epigastric tenderness. Urine was normal. Kline test negative. Hemoglobin, 11.5 Gm.; R.B.C., 3,850,000; W.B.C., 12,000, polymorphonuclears 72 per cent. Blood cholesterol, 286 mg., per 100 cc.; the Graham-Cole dye test revealed a nonfilling gallbladder. The stomach revealed a 40 per cent retention of barium at the end of six hours, but no other demonstrable pathology.

Operation.—June 19, 1937: Exploration revealed the stomach dilated about twice the normal size and hypertrophy of the gastric wall. In the anterior wall of the pylorus, a tumor mass, about 3 Mm. in diameter, projected through the muscularis. This visible mass was the "spearhead" of a button-shaped tumor, about 1.5 cm. in diameter, that could be palpated in the pyloric wall. Through an exploratory incision in the stomach wall, the pylorus could be seen firmly contracted to a diameter of 1 cm.; it could not be dilated. The mucosa opposite the mass had a normal appearance. The gallbladder was normal to inspection and palpation. The appendix was bound down by many adhesions.

The tumor mass and two-thirds of the pyloric sphincter were excised, and a Judd type of pyloroplasty was performed. The appendix was removed.

Pathologic Examination.—Gross: Dr. D. C. Beaver. The specimens consist of a resected portion of the pylorus of the stomach and the appendix. The pylorus reveals hypertrophy of the muscularis, and a definite, firm, nodular zone within the muscularis, which measures 1 cm. in diameter. The mucous membrane is not ulcerated.

Microscopically, the surface epithelium is intact and normal in appearance. The pyloric glands are normal. The superficial portion of the mucous membrane is infiltrated by lymphocytes, which are sometimes organized as lymph follicles. The supporting connective tissue of the mucous membrane is normal in appearance. The muscularis mucosa is normal. The submucosa is normal. The muscularis externa presents marked and uniform hypertrophy of all three layers. The hypertrophy is the result of an increase in size of unit muscular structures and the presence of a large number of ducts and glands. The ducts are lined by columnar, mucus-producing epithelial cells. They vary in size from small to large major ducts, which are usually dilated. The smaller components appear to unite to form the larger ones. Dense connective tissue is present as supporting structure around the ducts. Occasionally lymphocytes are infiltrated in the periductal connective tissue. In the neighborhood of larger ducts, glandular tissue having the histologic characteristics of pancreatic acinar tissue is found (Fig. 1). Islands of Langerhans are not present. At no point do the ducts appear to empty upon the surface in the sections studied. All cells of the ducts and glands are mature and adult in type. The ducts and glandular tissue are present in all parts of the muscularis externa, from submucosa to serosa, but a larger number are found in the middle circular muscular layer.

The myenteric plexus is composed of hypertrophic nerve cells. *Pathologic Diagnosis.*—(1) Heterotopic pancreatic tissue and pancreatic ducts in the wall of the pylorus. (2) Hypertrophy of the muscularis externa of the pylorus. (3) Chronic catarrhal appendicitis.

Convalescence was uneventful. At the present writing, one and one-half years after



FIG. 1.—Photomicrograph of a section through the muscularis externa of the pylorus disclosing multiple ducts of varying size and islands of pancreatic acinar tissue. (H & E stain—X100)

operation, the patient has been free of symptoms, with the exception of minor attacks of duodenal spasm, apparently precipitated by familial discord. Fluoroscopic examination and the clinical course at all other times reveals normal function.

Ritter[16a] has offered two explanations for the spasm of the intestinal muscle in the presence of heterotopic pancreatic tissue. One, an attempt by the musculature to abort a foreign body, and, two, the chemical irritation by pathologic change in the normal composition of the secretion. In my opinion, it would be more logical to believe that the source of irritation was the result of any pathologic change that involved the aberrant tissue.

Table IV presents the cases found in Poppi's series that have concomitant peptic ulcer and heterotopic pancreatic tissue. The first two cases have the ulcer superimposed upon the heterotopic tissue. These cases suggest that the careful surgeon should at least look for heterotopic tissue and consider the removal of any peptic ulcer as a part of the operative technic.

COMMENT.—A review of the material relevant to this subject strongly suggests that constant stimulation of local intestinal musculature by pathologic changes in the aberrant pancreatic tissue have produced chronic contraction

and hypertrophy as an end-result, and that the difference between the cases represented in Tables II and III is that of time and the degree of irritation.

When the surgeon is confronted by normally appearing organs, in a case

TABLE IV

CASES PRESENTING PEPTIC ULCER AND HETEROTOPIC PANCREATIC TISSUE (POPPI)

Author	Site of Pancreatic Tissue	Pathology
Ashanazy	Stomach	Cystic mucosa + duodenal ulcer
Cardwine and Short	Stomach	Acute necrosis of heterotopic pancreatic tissue, with superimposed ulcer
Cave	Duodenum	Duodenal ulcer
Ciceri	Jejunum	Duodenal ulcer
Deaver and Reiman	Duodenum	Superimposed ulcer
Del Valle, Braghetto and Briand	Stomach	Juxtapyloric ulcer causing hypertrophic stenosis
Fumagalli, No. 1	Duodenum	Stellate cicatrix of a pyloric ulcer
Fumagalli, No. 2	Duodenal diverticulum	Cicatrix of a duodenal ulcer
Heinekampf	Duodenum	Duodenal ulcer
Okinczyc, No. 2	Jejunum	Gastric ulcer
Pignatti	Duodenum	Gastric ulcer
Sicca	Stomach	Duodenal ulcer
Sussi, No. 1	Jejunum	Duodenal ulcer
Sussi, No. 2	Stomach	Prepyloric ulcer
Wohlhill	Stomach, fundus	Gastric ulcer
Zanatti	Jejunum	Duodenal ulcer

presenting clinical signs of peptic ulcer, cholecystitis, or appendicitis, a careful visual and palpatory search should be made for heterotopic tissue in the region of the upper gastro-intestinal tract. In the very rare case, an ulcer, may be produced by necrosis of the heterotopic pancreatic tissue. Peptic ulcer and an aberrant pancreas may be found together.

TREATMENT.—The treatment of heterotopic pancreatic tissue is the surgical removal of the mass and the correction of complications that may be present. When pyloric obstruction is present, any applicable technic may be employed to restore the normal gastro-intestinal canal with the exception of the Ramm-stedt-Fredet procedure.

CONCLUSIONS

(1) Heterotopic pancreatic tissue occurs more frequently than present statistics would seem to indicate, and produces symptoms in only a few cases, but when symptoms are produced they are frequently the result of pathologic changes that are common to the parent gland.

(2) The surgeon should familiarize himself with the gross aspects of this tissue and should resort to frozen-section at the time of operation.

(3) An explanation of the etiology of pyloric obstruction in these cases is offered.

The author wishes to express his sincere appreciation to Dr. D. C. Beaver for his enthusiastic help and criticism in the preparation of this communication.

REFERENCES

[1] Beaver, Donald C.: Persistent Truncus Arteriosus and Congenital Absence of One Kidney, with Other Developmental Defects. Arch. Path., 15, 51, January, 1933.

[2] Branch, C. D., and Gross, R. E.: Aberrant Pancreatic Tissue in Gastro-Intestinal Tract: Report of Two Cases. Arch. Surg., 31, 200, August, 1935.

[3] Cecchini, S.: Ectopic Congenita Della Testa del Pancreas e Consecutive Gastrestasia. Rassegna di sc. med. Modena., 1, 314, 1886.
[4] Choisser: Aberrant Pancreas of Pylorus with Report of Case Resembling Neoplasm. U. S. Naval Bull., 22, 322, 1925.
[5] Cohen, H.: Accessory Pancreas with Ulcer of Pylorus. Surg., Gynec., and Obstet., 34, 384, 1922.
[6] Crosby, E. H., and Graham, A.: Mediastinal Dermoid Cyst Containing Pancreatic Tissue. J.A.M.A., 98, 1789, 1932.
[7] Danzis, Max: Aberrant Pancreatic Tissue in the Gastro-Intestinal Tract. Report of Two Cases. Surg., Gynec., and Obstet., 67, 520, October, 1938.
[8] Delhougne, F.: Über Pankreaskeime im Magen. Arch. f. Klin. chir., 129, 116, 1924.
[9] Gruber, Herle, Roth: Deutsch. z. Chir., 179, 365, 1923.
[10] Hedry: Accessorischen Pankreas. Bruns' Beitr., 130, 1924.
[11] Hilarowicz, H.: Accessory Pancreas and Brunner's Glands in the Stomach (So-Called Brunner's Adenoma). Zentrabl. f. chir., 54, 1610, June 25, 1927.
[12] Holzweisig: Quoted by Simpson.[17]
[13] Hunt, V. C., and Bonesteel, H. J. S.: Meckel's Diverticulum Containing Aberrant Pancreatic Tissue. Arch. Surg., 38, 425, 1934.
[14] Munch, H.: Mitt. a. d. Grenzgeb. d. Med. u. Chir., Jena., 38, 538, 1924–1925.
[15] Poppi, A.: Aberrant Pancreas—Complete Review of the Literature. Arch. Ital. del Mal. Apparat. Diger., 4, 534, 1935.
[16] Reynier and Masson: Stenose Pyloreque due a un Lobule Pancreatique aberrant. Bull. Acad. de méd., Paris, p. 100, 1909.
[16a] Ritter, Leo: Zum klinischen Bilde und Sitz versprengter Pankreaskeime. Bruns' Beitr., 124, 157–171, 1921.
[17] Simpson, W. M.: Aberrant Pancreatic Tissue: An Analysis of 150 Cases. Contributions to Medical Science. Ann Arbor Mich. George Wahr, p. 435, 1927.
[18] Taylor, A. L.: Epithelial Heterotopias of the Alimentary Tract. Jour. Path. and Bacteriol., 30, 415, 1927.
[19] Thorel: Histologische Über Neben Pankreas. Virchows Arch., 173, 1903.
[20] Tschudi, Jr., E.: Über Einen Fall Von Versprengten Pankreaskeime im Pylorus der ein Carcinoma Pyloric Vortanschte. Schweiz. med. Wchnschr., 12, 986, 1931.
[21] Warthin, A. S.: Two Cases of Accessory Pancreas. Physician and Surgeon, 26, 337, 1904.
[22] Weishaupt: Virchows Arch., 223, 1917.
[23] Zenker, F. A.: Nebenpankreas in der Darmwand. Virchows Arch. f. Path. Anat., 21, 369, 1861.

ILEOJEJUNITIS

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ILEOJEJUNITIS may be defined as the subvariety of regional enteritis in which the granulomatous process typical of that disease extends to involve the upper ileum and the lower or whole of the jejunum.

The original descriptions of regional ileitis concerned the form of ulcerous and hyperplastic inflammation in which the terminal loops of the small intestine, just proximal to the ileocecal valve, are implicated.[1, 2, 3] It was soon recognized that the pathologic process, while presenting its most typical aspect in the terminal ileum, was not restricted to that area; it could and did extend, in a limited number of cases, to the higher loops of small intestine and also, on occasion, transcended the valve to involve the cecum and colon.

It is appropriate to recognize that the clinical picture of upper ileojejunitis is somewhat different from terminal ileitis, bearing its own clinical, pathologic, and roentgenographic characteristics. While allowing it to remain within the category of regional enteritis, upper ileojejunitis has certain clearly recognizable and distinguishable settings.

To contrast the two forms, *terminal ileitis* is marked by a localized granulomatous mass; by numerous external and internal fistulae; by perirectal abscesses; by obstructive intestinal phenomena; and a low-grade febrile clinical course with slowly progressive inanition. The localized process is highly amenable to surgical intervention.

Ileojejunitis is the same ulcerative granulomatous disease extending orally for a variable distance to and including the jejunum, but without the mass, usually without fistulae or rectal complications, without obstructive phenomena. It is, in general, not favorable to surgical help. The course is low-grade, often less severe; a considerable degree of healing under conservative medical therapy is possible, though a complete anatomic restitution to integrity of the bowel is not conceivable.

Etiology.—To date, our experience with regional ileitis or enteritis approximates almost 200 cases. Out of this large number we are able to separate 17 examples of diffuse or high ileojejunitis. The latter serve as the basis for this report. It is immediately obvious that, in comparison with terminal ileitis, ileojejunitis is a less common form, occurring in proportion approximately one to ten of all granulomatous cases.

The age incidence in ileojejunitis is again one of youth, the average age at observation being 25½ years (terminal ileitis 27½ years), the range ex-

Submitted for publication July 26, 1940.

tending from a child of nine years to a maximum seen in a man of 70. Males predominate in the proportion of over two to one, 12 males to five females.

As regards the direct etiology of the disease, no further or new knowledge is available. The process is definitely not tuberculous, either by culture, histology, staining, or by animal inoculation.

In two instances we were able to recover a *Shigella dysenteriae* of the Flexner variety from the stool of the patients, proven by culture, reactions on sugar media, serum agglutinations, and absorptive phenomena carried out on the cultures.

Ileitis as a disease may be a clinical variety of dysentery, or at least at its initiation it may originate as a dysentery infection. If so, then the difficulties in discovering and recovering viable dysentery organisms from the stools of chronic cases is obvious to anyone familiar with the bacteriologic aspects of epidemic dysentery. In a recent endemic of typical dysentery in the personnel of the Training School for Nursing, of the Mt. Sinai Hospital, during the summer of 1939, over 250 cases were observed and studied. Positive dysentery cultures of the Newcastle strain were recovered in a large percentage of the cases (79.4 per cent), but only in the first one to three days of the onset; after that initial period, cultures of the stools were almost uniformly negative.

If ileitis is dysenteric in nature, then the difficulty of obtaining cultures in cases which have already run a course of from one to 14 years, before coming under observation, is self-evident. The ability to recover, in two of the 17 cases of ileojejunitis, viable Flexner organisms, is certainly striking. Again, one of the cases seen was a younger brother of one of the 14 original cases[1] of terminal ileitis. The brothers had lived together for some time, and the possibility of a transfer infection, through food handling and careless toilet hygiene must be considered. This latter instance is now one of five examples of ileitis in siblings, among whom, two, and in one instance, three members of the same family were affected.

On the other hand, to date, as far as we know, none of the 250 nurses, involved in the hospital epidemic of 1939, have developed any sequelae or evidence of any chronic symptoms of the malady, either as chronic colitis or as ileitis.

Pathology.—The pathology of ileojejunitis varies only slightly from that of regional ileitis. It is a granulomatous and ulcerating, nonspecific inflammation, in which all of the coats of the intestinal wall, particularly the submucosa, undergo a granulomatous, proliferative change. The overlying mucosa undergoes a process of linear necrosis, paralleling the extension of the ulcerative process. Miliary-like tubercles consisting of lymphoid and epithelioid mononuclear cells are common and frequently enclose giant cells, probably of foreign-body nature.

Grossly, dense mass formation in ileojejunitis is unusual, nor does the process concentrate on any one area to produce a large granuloma with encroachment upon the lumen of intestine, as is seen in terminal ileitis. The

process is more diffuse, a large part of the small intestine is usually involved (except for the duodenum) by numerous "skip-areas," separated by large-spaced distances of free mucosa. The process does not reside in one place long enough to create obstruction to the lumen or to originate fistulous tracts; instead, the disease seems to disseminate its power, continually advancing upward by kangaroo-like jumps to involve higher intestinal segments (Chart 1). Enlarged mesenteric lymph nodes accompany the extension of the dis-

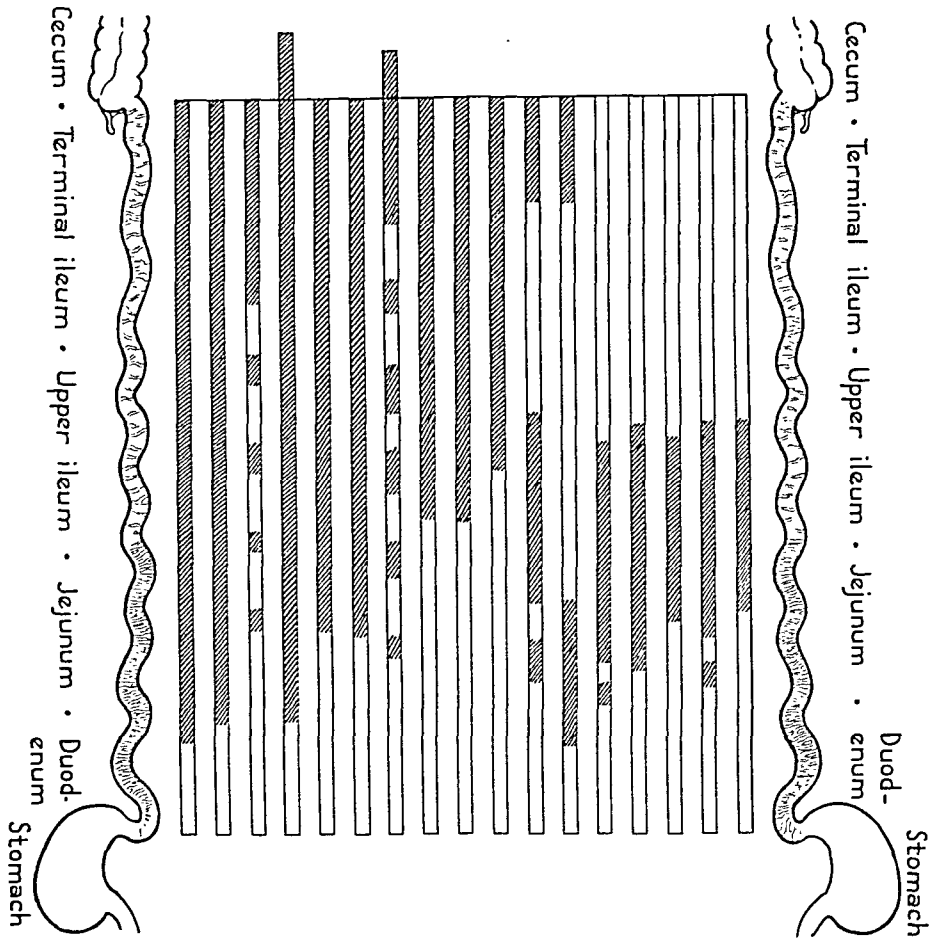


CHART 1.—Demonstrating, graphically, the anatomic distribution of the lesions in diffuse or high ileojejunitis. (Shaded areas denote the extent and location of the pathologic involvement.)

ease, though the nodes in the mesentery of the upper ileum and jejunum rarely achieve the massive and succulent proportions seen in the mesentery just proximal to the ileocecal valve. Whether the extension of the malady to new intestinal areas is achieved by mucosal transport or by invasion of the lymphatics is still controversial.

In only two cases were fistulous tracts observed; in one, an ileorectal fistula, in another, an ileo-ileal fistula occurred. External fistulae to the abdominal wall were not observed, even though the recent scars of an exploratory celiotomy existed in five cases (in contrast to regional or terminal ileitis).

Symptomatology.—The onset is usually gradual (15 cases), the duration

of the symptoms, when first seen, being from six months to 14 years (average, three and one-half years). Only two cases presented an, apparently, acute onset: one, with gross hemorrhage, the other, with an acute febrile course. Both cases, when seen, were, however, already well-advanced in the chronic phases of the disease. Four patients had previously undergone an ineffectual appendicectomy.

The outstanding symptoms in all cases were: (1) A low-grade febrile course. (2) Abdominal pain, often amounting to severe cramps. (3) Diarrhea. (4) Gross hemorrhage. (5) Anorexia. (6) Marked loss of weight.

The temperature remained within normal range in six instances, and was elevated to 100° to 104° F. in the remaining 11 cases. The fever was irregular in nature, sustained often for several days or weeks, or alternating with periods of apyrexia.

Abdominal pain and cramps were universally present—diffuse, moderate at times, severe at others; ranging over the lower abdominal segments and periumbilical region. Paroxysms of severe cramp-like pain were common in both lower right and lower left iliac quadrants, usually followed by a diarrheal movement. With the passage of the fluid feces and gas, accompanied by an audible gurgling, the cramp was allayed. At times, the paroxysms called to mind low-grade intestinal obstruction, though none of the 17 cases ever came to operation because of suspected obstruction.

Diarrhea was universally present, two to four or six stools per 24 hours. This diarrhea is less severe than is seen in ulcerative colitis; the stools are mushy, or semisolid, and when more frequent, actually watery, containing mucus, but no pus, and only occasionally blood. At times, constipation alternated with diarrhea. It is of interest that the guaiac reaction in the feces was positive in ten cases, but persistently negative in five cases. Gross hemorrhage was present in three patients, in one, as the initial symptom.

Anorexia was a common manifestation, particularly in the febrile cases, and was associated in all instances with a marked loss of weight. The average weight loss amounted to 17½ pounds, the extremes ranging from four to 40 pounds. During the healing phases, after the initial stages of severity have passed, actual gains of 15 to 25 pounds of body weight have been observed.

Nutrition is usually poor, the skin dry, the mucous membrane pallid. An aphthous stomatitis was observed twice, and in one of these patients recurrent aphthous ulcers were accompanied by bleeding gums. Except for these manifestations of hypovitaminosis no striking clinical changes characteristic of vitamin deficiency were observed.

The degree of anemia was not marked; in one case, a low of 50 per cent was reached, but many patients preserved a hemoglobin ranging between 75 and 94 per cent. One patient had a macrocytic hyperchromic type of anemia, with a color index of 1.3. This individual had been treated as a case of sprue until a gastro-intestinal roentgenologic study showed the characteristic changes of ileojejunitis; interestingly enough, and in contrast with sprue,

the macrocytic anemia improved only slightly with daily injections of liver extract—a maximum reticulocyte response of only 7 per cent being attained. The remaining patients with anemias presented blood pictures of the microcytic hypochromic variety.

The leukocyte count in ileojejunitis was usually within normal limits, the highest (which was most unusual) being in one instance 12,900, and in another, 18,000 cells. The differential count was noteworthy of deviation from the norm in that a relative or absolute eosinophilia was present in five patients, the highest content being 14 per cent.

Oral glucose tolerance tests were performed on seven patients, and in five, flat curves consistent with poor absorption were obtained. The erythrocytic sedimentation rate exhibited varying degrees of acceleration in five patients (22 to 50 minutes—normal being 60 minutes or more). Sedimentation rates were increased in three of Snapper's[6] six cases of chronic ileitis. The total protein in the blood plasma was appreciably lowered (5.8 Gm.); in three cases, reaching a minimum of 4.0, 4.4 and 4.5 Gm. per 100 cc.; the albumin-globulin ratio was persistently disturbed, approaching a ratio of one, but never completely reversed. The urea, blood sugar, and phosphorus in the blood plasma were within normal ranges. The blood calcium was reduced in one patient; another patient showed an osteoporosis of the pelvis, thought to be due to loss of calcium in the stool. Improvement was noted following calcium therapy. Gastric analysis showed normal acidity titers in all cases except in one instance in which a true achylia was present.

Tuberculin reactions (Mantoux and von Pirquet) were negative. Dysentery agglutinations for B. Flexner, Hiss, Shiga, Mt. Desert, and Sonne were negative in eight patients, and the blood Wassermann reaction was negative in all. Roentgenograms of the lungs in many cases were entirely negative.

The Physical Examination.—The physical examination of the patient, apart from malnutrition and pallor, evidenced tenderness over the entire abdomen, frequently more marked in the lower segments. A mass was never felt, nor were external abdominal wall fistulae observed. Visible peristalsis was not present. The edge of the spleen was occasionally palpable, soft and sharp.

The rectal examination was always negative, this again contrasting with terminal or regional ileitis in which a pelvic mass or induration is frequently palpable and corresponds to an involved localized granuloma with localized peritonitis and diffused fistulous tracts. Sigmoidoscopy was always negative.

Roentgenologic Studies.—The diagnosis of ileojejunitis, being marked by the lack of physical signs, rests mainly on roentgenographic evidence. The barium enema is usually the first procedure, for in every case of persistent diarrhea, the primary interest rests in recognizing or excluding an ulcerative colitis. A negative sigmoidoscopy does not exclude the possibility of a right-sided segmental colitis, the evidence of which is clearly demonstrable following a barium clysma.

In most cases of ileojejunitis the opaque enema is negative (15 out of 17

observations). In one instance a persistent cecal spasm, in another, definite spasm and deformity of outline in the transverse and descending colon gave warning of colonic participation in the process; this was confirmed at celiotomy.

The eventual diagnostic procedure was, and is, the barium meal, as performed with a reduced amount of barium (four ounces or less), and with frequent fluoroscopic observations and roentgenograms. When properly carried out, the roentgenographic demonstration of the disease is, and should be, a relatively simple task.

By roentgenologic studies following a barium meal, the degree and extent of ileal and jejunal involvement are definable with a good degree of accuracy. The lower jejunum and upper ileum were always seen to be involved; in five instances, the terminal ileum seemed to be exempt from the process. In two cases, six to seven inches of terminal ileitis was followed by a long free area, the distal half of the ileum and the lower jejunum being again the seat of an advanced pathologic process. Occasionally, clearly marked "skip-areas" were easily demonstrated in the roentgenograms.

Ten of the 17 cases have been subjected to exploratory celiotomy, in all of which the roentgenographic diagnosis of the disease, as well as the extent and degree of invasion, were amply and accurately confirmed.

Differential Diagnosis.—In terminal ileitis it is important to exclude primary and secondary tuberculosis and neoplasm, both of which are marked by extremely severe courses and are readily differentiated roentgenologically and by laboratory examinations.

With upper ileojejunitis, an entirely dissimilar problem comes into play. Here, benign new growths are uncommon, but Hodgkin's disease and sarcomatosis occur and are characterized by rapidly downhill course with hemorrhage and emaciation.

The main point in high ileojejunitis is to exclude nontropical sprue, and the intestinal manifestations of the deficiency diseases. Clinically, nontropical sprue is characterized by frequent, frothy stools, and by the finding of a severe anemia, frequently of the hyperchromic type. Fever is absent, the stools do not contain blood, and gross hemorrhage from the bowel is absent. The cases react well to liver extract, to careful and judicious dieting, and to hygienic measures. The roentgenographic picture of the small bowel in sprue is one of uneven distribution of the barium in the several loops of the jejunum and ileum, with delay in motility of the upper loops, and without changes in the terminal ileum.[7, 8]

It is necessary to differentiate ileojejunitis from the deficiency states and the disturbances of fat metabolism as described by Snell and Camp,[9] Kantor,[10] and by others. The small intestinal changes accompanying ulcerative colitis which have been described by Mackie and Pound,[11] are probably also deficiency states. The roentgenograms in both conditions are of a nature similar to that described in sprue, namely, mild puddling, delay and irregular outlines of the upper jejunum and ileal loops, absence of delay in the terminal ileum.

In true ileojejunitis of the granulomatous type, the whole small intestine including the lower and terminal ileum, is usually involved; but even when only isolated segments of upper ileum and jejunum are implicated, the roentgenographic appearance is quite characteristic. Prolonged delay and accumulations of barium in upper loops is unusual; the various involved segments are irregular and fuzzy in outline; areas of narrowing in the lumen (signifying involvement) alternating with areas of dilatation ("skip-areas") usually increase in severity as one travels distally and is most marked in the



FIG. 1.—Roentgenogram showing the change in outline and in the mucosal pattern in the upper ileum and lower jejunum.



FIG. 2.—Roentgenogram showing the almost continuous "string-sign" involving the whole of the lower and upper ileum.

terminal loops of ileum where the pathognomonic "string-sign" just proximal to the ileocecal valve is frequently observed (Figs. 2 and 3).

Course and Prognosis.—The progress of a case of ileojejunitis depends, to a considerable degree, upon the severity and extent of the disease and the amount of involvement of the small bowel. In those instances in which the greatest part of the small intestine is continuously or intermittently continuously involved, surgical treatment is logically out of the question. To resect the whole implicated area, leaving only the jejunum and duodenum to assume the vital functions of chymification and absorption is to invite disaster. To attempt a high short-circuiting operation, of jejunum to colon, is tantamount to a total exclusion of the small intestine, and is again representative of poor surgical judgment. In those widely diffuse cases, medical treatment, whatever that implies, is the only resort, and is apparently, from a study of conservatively treated cases, most promising.

Nine such cases which have been observed during the last five years have not had recourse to surgical treatment. Four have done very well, having gained strength and weight, in one instance, up to 50 pounds.

The remaining five conservatively treated cases, have gained some weight, anemia has diminished and the frequent bowel movements have decreased and been held under control. The treatment instituted has consisted of a strict nonroughage diet, very liberal vitamin therapy, the administration of iron and liver extract particularly by mouth, and the insistence on rest, sun-



FIG 3.—Roentgenogram showing the extent of the diffuse ileitis when first seen.



FIG 4.—Roentgenogram of the same case as shown in Figure 3, three years later, after a gain of approximately 30 pounds. Note the partial restoration of the width of the intestinal lumen and mucosal pattern

shine and change of air. The fecal movements are controlled, where necessary, by very small doses of opium after alternate defecations. No specific form of therapy can be evolved in the absence of knowledge of the specific causative agency of the disease. Roentgenotherapy has proven useless, as have also occasional recent attempts at chemotherapy with the newer sulfanilamide compounds.

Clinical and symptomatic improvement takes hold gradually and seems to gain momentum as the years progress. In all the cases in which careful follow-up roentgenologic studies have been made, the observations continue to show the characteristic small bowel changes as originally seen at the first examinations (Figs. 3 and 4). This fact is most significant; two cases have been continually observed for five years; each case has gained from 30 to 50 pounds and is apparently quite well except for mild persistent diarrhea.

Where the disease begins before or at puberty a considerable retardation

of secondary sexual development takes place. One boy was 18 years old, weighed 81 pounds, had infantile testicular development, and was devoid of pubic or axillary hair. His voice was high-pitched and effeminate. (Case quoted by courtesy of Dr. John Sproul of Haverill, Mass.) The second boy, who has done very well on medical therapy, has permanently overcome his developmental sexual retardation, and with the subsidence of active symptoms has finally gained considerable weight, grown to normal stature, and has shown secondary sexual development.

Results and Nature of Surgical Intervention.—Apart from exploratory operations, and the usually needless appendicectomy, a study of the attempts to approach this problem by radical surgical procedures is most interesting. Two cases had undergone wide and extensive resections of the lower bowel and cecum, including all of the ileum, and in one instance, much of the jejunum. The former case survived (Dr. A. A. Berg), and eventually gained 20 pounds in weight, but of late has lapsed, with the development of a diffuse colitis. The latter, and still more extensive resection, died of exhaustion and shock during his immediate postoperative course. Obviously, radical excision of the small intestine, in most of its entirety, is not to be recommended. In a third case, a high jejunocolostomy had been ill-advisedly performed elsewhere. An attempt to revise the operation and to stay the rapidly downhill course by taking down the anastomosis, resulted in a fatal peritonitis. In still another case, a man, age 71, with a course suggestive of neoplasm, a resection of 45 cm. of ileum was performed, though a more diffuse involvement was recognized at the time. This procedure also resulted fatally, and, at autopsy, the whole small bowel was seen to be almost continuously involved in the granulomatous ulcerative process. The operation was forced by the internists because of the obviously hopeless issue under conservative management.

These four cases (with only one survivor) demonstrate the futility of attempting to resect and excise so extensive a disease process.

Attempts at partial resection where the disease is not continuous, or where the distal ileum is exempt and only segmental high ileojejunitis exists, may possibly give more promising results. In two of the cases of restricted, high ileojejunitis, localized resections were performed involving in one case, 90 cm., in the other case, 75 cm. of upper ileum and lower jejunum. In the former case (case of Doctor Sproul), subsequent roentgenologic studies showed residual disease in the small bowel; at a subsequent celiotomy, it was obvious that the entire ileum and jejunum were markedly thickened, edematous, with roughened serosal surface, and a plastic peritoneal exudate. The colon appeared normal. Considerable later clinical improvement has taken place, but this betterment may well be attributed to the meticulous hygienic and conservative treatment instituted since the attempts at reconstructive surgery.

The second case of localized ileojejunal resection is too recent to allow

of any conclusion, although the patient is rapidly gaining weight, and is completely free of symptoms.

What shall or what can the surgeon do who opens the abdomen of a patient and finds a diffuse ileojejunitis involving not only in a severe degree the terminal ileum, but by continuous "skip-areas" the whole extent of the small bowel practically up to the duodenum? To close the abdomen without making some attempt at resection appeared in these remaining two cases as a surrender without an effort at some type of reconstructive surgery. In both instances, the downward preoperative clinical course and the progressive loss of weight and inanition marked the ineffectiveness of conservative attempts at therapy. In this extremity, both redoubtable and experienced surgeons decided upon the same procedure, namely, to resect the most advanced lesion in the ileocecal area (terminal ileum and ascending colon), with the performance of a transverse ileocolostomy. In both instances (Dr. A. A. Berg and Dr. J. W. Hinton) the obviously diseased upper ileum and jejunum were returned to the abdomen. Both patients made uneventful operative recoveries, and, remarkable to say, have apparently continued to show marked improvement (six and three months postoperative).

The improvement in these last two cases is real and cannot be doubted, though it is against all our experiences regarding the success or failure of surgery in regional ileitis. The 10–15 per cent of conceded recurrences following resection for regional ileitis are actually attributed to the fact that higher "skip-areas" have been overlooked at the time of operation. If that be the case, then any palliative and partial resections, such as these latter two, in which no attempt was made to include the higher diseased area, should have been total failures. One would expect to see a rapidly continued downhill course. Not so, however, for the postoperative course has been and continues to be most promising. How to explain such a deviation from the rule is most difficult.

Until medical science reveals how ileitis spreads, whether by mucosal transport or by lymphatic extension; until the cause of recurrences after resection shall have been adequately demonstrated, and the significance of "skip-areas" made clear, the explanation of clinical postoperative betterment in these two unusual cases will remain enigmatic.

REFERENCES

[1] Crohn, B. B., Ginzburg, L., and Oppenheimer, G. D.: J.A.M.A., 99, 1323, 1932.
[2] Crohn, B. B.: A.J.D.D. and Nutr., 1, 97, April, 1934.
[3] Crohn, B. B.: A.J.D.D. and Nutr., 3, 736, December, 1936.
[4] Plum, P., and Warburg, E.: Acta Med. Scandinav., 102, 449, 1939.
[5] Butt, H. R., and Watkins, C. H.: Ann. Int. Med., 10, 222, 1936
[6] Snapper, I.: Pseudotuberculosis in Man. Amsterdam, Holland, 1938.
[7] Mackie, T. T.: Med. Clin. North America, 17, 165, 1933.
[8] Mackie, T. T., Miller, D. K., and Rhoads, C. P.: Am. Jour. Trop. Med., 15, 571, 1935.
[9] Snell, A. M., and Camp, J. D.: Arch. Int. Med., 53, 615, 1934.
[10] Kantor, J. L.: Am. Jour. Roentgenol., 41, 758, 1939.
[11] Mackie, T. T., and Pound, R. E.: J.A.M.A., 104, 613, 1935.

NEPHRO-OMENTOPEXY AND NEPHROMYOPEXY IN THE TREATMENT OF ARTERIAL HYPERTENSION*

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THE PROBLEM of increased arterial blood pressure has assumed vast importance in recent years. As a cause of death, it is preeminent since, directly or indirectly, hypertension causes four times as many deaths as does cancer; moreover, its victims fall into a lower age-group than do those of malignant disease. The resistance of hypertension to effective medical treatment has attracted the surgeon to the problem and his attack has centered particularly upon the nervous system (splanchnic resection, anterior nerve root section, *etc.*), the objective being the elimination of vasomotor stimuli to the vascular tree. In general, the results of these operations have not been up to expectations.

The classic work of Goldblatt and his associates[1] on the production of hypertension in animals (dogs and monkeys) by constricting the main renal arteries stimulated the present studies. These workers found that constriction of only one renal artery was followed by hypertension lasting for days or weeks, the blood pressure eventually returning to the normal level; chronic persistent hypertension could be produced only by constricting both main renal arteries (bilateral renal ischemia) or by constricting the main renal artery of one kidney and removing the other kidney. They observed that in animals with experimental hypertension, whenever the blood pressure fell to a lower value it was due either to inadequate clamping of the renal arteries or to the development of an adequate collateral circulation by the kidney through the ureteral and capsular vessels.

It follows naturally that if human essential hypertension is the counterpart of hypertension produced in animals by renal ischemia, an adequate collateral circulation brought to one or both kidneys would be followed by a return of the blood pressure to lower levels. However, there is a fundamental difference between the two forms of hypertension. In human essential hypertension renal ischemia is rarely due to obstruction of the main renal arteries (such cases, however, have been described) but to a diffuse narrowing of the preglomerular arterioles. It seemed important, nevertheless, to determine whether an improvement of the vascular supply to the human kidney by increasing the accessory circulation would result in a fall in blood pressure

* Read before the joint meeting of the New York Surgical Society and the Philadelphia Academy of Surgery at the New York Academy of Medicine, February 8, 1939. Submitted for publication May 22, 1939.

in patients with arterial hypertension. As will be described in detail later, this has been accomplished by approaching the kidney through the abdominal route, decapsulating the organ, and finally enveloping it in a new fatty capsule of omentum (nephro-omentopexy) or by placing the decapsulated organ in contact with the surfaces of the quadratus lumborum and psoas muscles (nephromyopexy).

Clinical and Experimental Basis for the Present Operative Approach.—The extent to which the omentum will supply blood to ischemic tissue in humans is well exemplified by the increase in the caliber of the omental vessels when this organ becomes attached to pedunculated uterine fibroids and uterine sarcomata. In dogs, Beck[2] and O'Shaughnessy[3] have shown that the grafting of skeletal muscle or omentum to the myocardium rendered ischemic by ligation of one or more of the coronary arteries is followed by increased vascularization of the heart. Approximately ten years ago, Pauntz,[4] and more recently, Davis and Tullis,[5] and MacNider and Donnelly[6] have demonstrated that an accessory blood supply to the normal kidney of the dog may be obtained by nephro-omentopexy. In these investigations, the kidney was prepared by introducing omentum into the incised cortex of the kidney. This procedure was avoided in the present operative approach in patients since it was believed that more scar tissue would be formed between omentum and kidney than when two normal surfaces are placed in apposition. In a previous report, it was shown that under these latter circumstances little or no scar tissue resulted from nephro-omentopexy in humans; at the same time it was demonstrated that communication between the omental and renal blood vessels occurred.[7]

Operative Procedure.—The anterior transperitoneal approach has proved adequate for the preparation of both kidney and omentum for nephro-omentopexy. The stages of the operation have been worked out on succeeding cases. In the first attempt, the operation was performed by the same approach, the arrangement of the omentum and the placement of the kidney being similar to the method in use at present. To this has now been added (a) the removal of a biopsy specimen of kidney substance performed by cutting out a wedge-shaped section of kidney cortex and by placing a mattress suture through the cortex to control bleeding; (b) brain clips have been clamped into the margin of the omentum at each suture point in order to later identify the omental position in relation to the kidney pelvis after an intravenous urogram; and (c) the surface of the kidney has been seared with a cautery, the assumption being that a light searing of the surface will cause an immediate active hyperemia.

The operative procedure (nephro-omentopexy) is relatively simple, requiring from 30 to 50 minutes to perform. The technic is illustrated in Figures 1 to 4, and described in their legends. The technic for nephro-myopexy does not require entering the abdominal cavity. The usual lateral oblique incision in the flank is used to reach the retroperitoneal space. The kidney is stripped of its fatty capsule and delivered into the incision in the

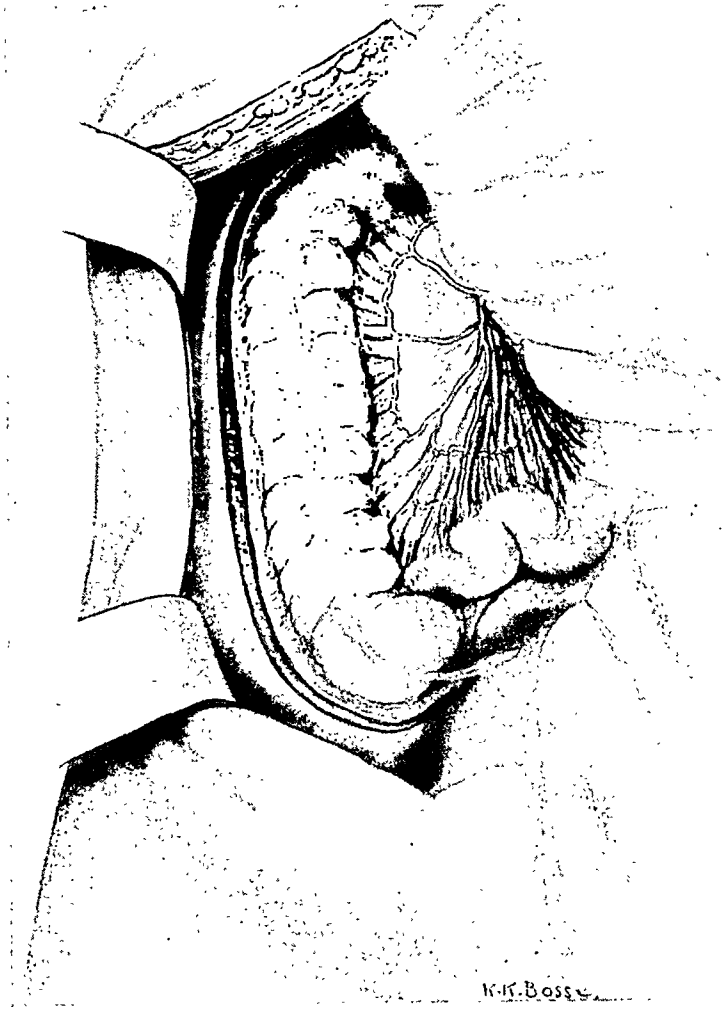


FIG. 1.—The approach is through a long external pararectus incision. The small intestines are packed off to the left of the abdomen. The upper abdominal peritoneum is incised externally to the ascending colon and cecum. In one instance (Case 6) this lateral incision was carried up to the level of the first portion of the duodenum; this was necessitated by an extremely short omentum.



FIG. 2.—The cecum and ascending colon are lifted away from the posterior abdominal wall. The kidney is freed from its fatty capsule by blunt dissection and delivered into the abdominal cavity. The true capsule of the kidney is divided along the convex border; the medial half of the capsule is removed close to the pelvis.

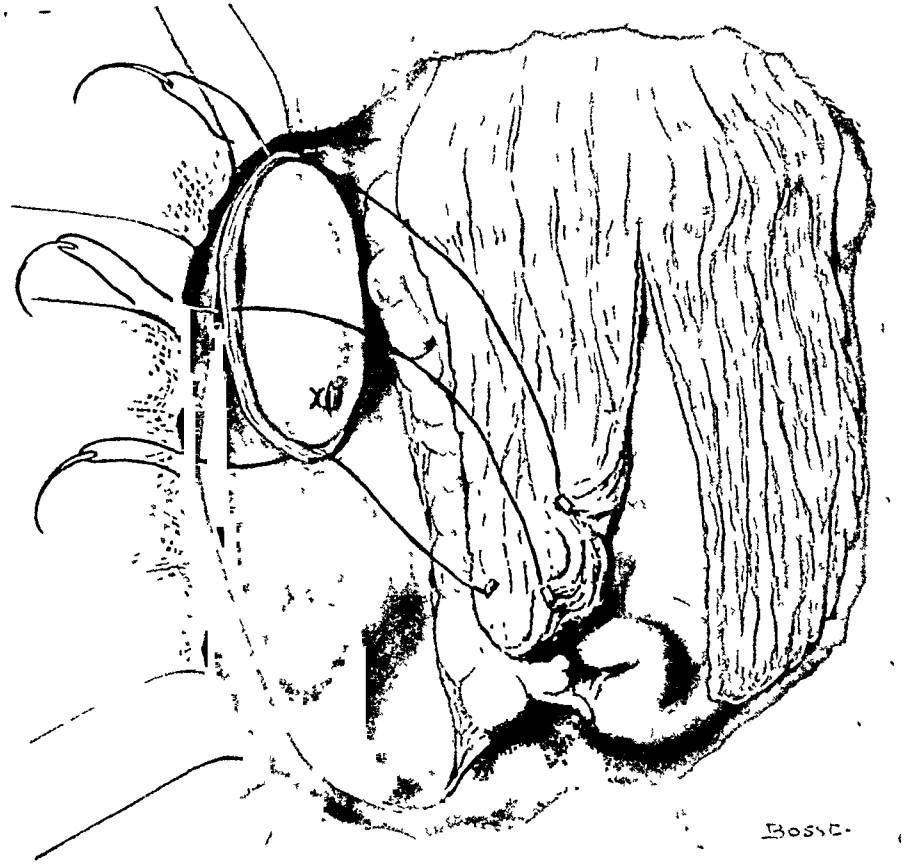


FIG 3.—The lateral half of the kidney capsule is divided near the kidney pelvis leaving a sufficient margin to suture to the omentum The omentum is divided in the midline, care being taken to avoid cutting any of the large vessels Removal of a biopsy specimen of the kidney is now taken, usually on the convex surface near the lower pole Superficial searing of the kidney surface is then carried out Brain clips are clamped into each corner and into the middle of the lower margin of the omentum. Leading sutures are taken from each corner of the omentum and from its lower midborder to each pole of the kidney and to the midline of the posterior cut margin of the capsule As the sutures are drawn up, the omentum is pulled upward and laterally to cover the convex and posterior surfaces of the kidney The kidney is then rotated and replaced in its normal position

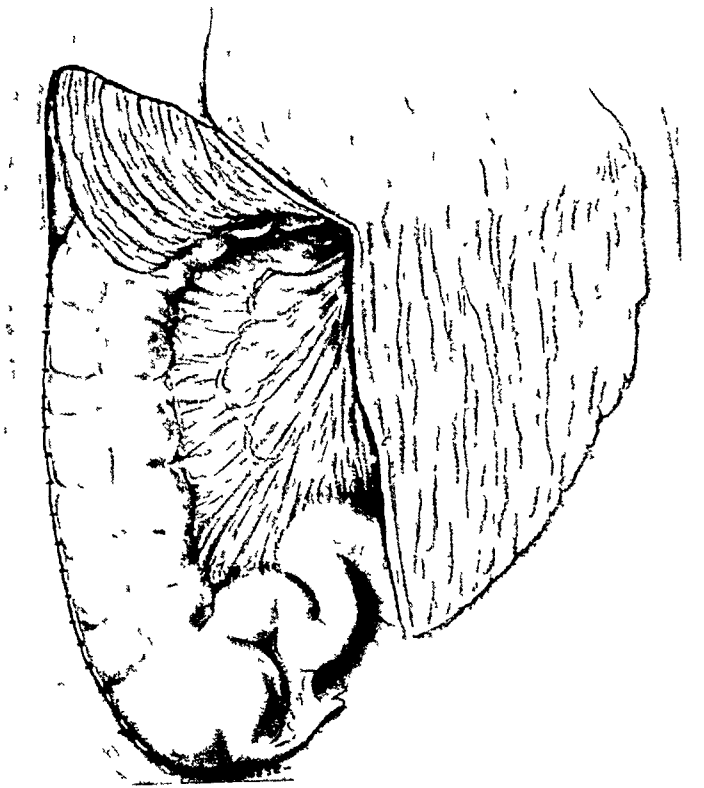


FIG 4.—The replacement of the kidney in the retroperitoneal space drags the omentum with it through the superior angle of the incision in the posterior parietal peritoneum The anterior surface of the kidney is covered in this way The lateral incision into the posterior abdominal peritoneum is then closed up to where the omentum leaves the abdominal cavity

usual manner. The true capsule is incised along the convex border of the kidney, stripped back and removed from the anterior surface of the kidney. On the posterior surface the capsule is divided along the pelvic border with enough margin left to suture to the left margin of the psoas muscle in order to support the kidney. The lumbodorsal fascia is removed from the quadratus lumborum and psoas muscles directly posterior to the kidney. In Case 7 the lower pole of the kidney could be slipped into the lumbodorsal fascia which served as an additional means of supporting the kidney (Fig. 5). As in the

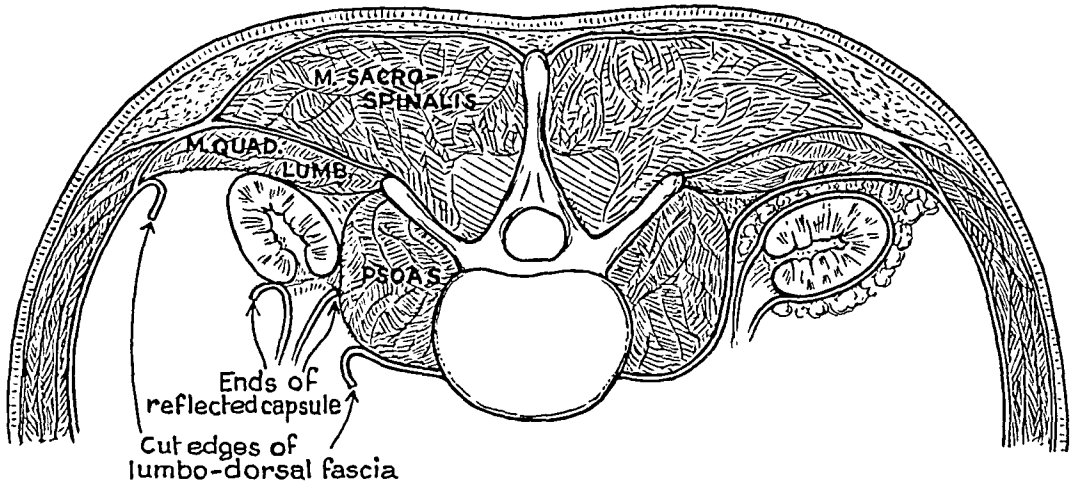


FIG. 5.—Relative position of the kidney and the surrounding muscular structure in nephromyopexy.

nephro-omentopexy, a biopsy specimen of the kidney is obtained, a brain clip inserted over this area, and the kidney surface seared prior to its apposition to the muscles.

Selection and Preoperative Investigation of Patients.—Each patient was hospitalized for 10 to 30 days prior to operation and a complete clinical and laboratory investigation carried out. This consisted of history and physical examination including eyeground studies, electrocardiogram, blood chemistry, urea clearance and other tests of kidney function, urine analyses and urine cultures, intravenous urogram and, where indicated, retrograde pyelograms. Blood pressures were taken at least once daily. Cases 5 to 9 were selected because of the lability of the blood pressure as shown by the degree of fall after sodium amytal (Allen and Adson[8]) and by the inordinate rise of the blood pressure after immersion of one hand in ice water (Hines and Brown[9]).

Since August, 1937, when the first operation of this type was attempted, six patients have had a right nephro-omentopexy, two a right nephro-omentopexy and six months later a left nephromyopexy, and one a right nephrectomy (for lithiasis and pyelonephritis) and four months later a left nephromyopexy. Two of the patients had nephritis. One of these (chronic diffuse glomerular nephritis) was operated upon not with a view to prolonging life but to determine whether the blood pressure would decrease following such an operative interference and if so to offset the rapidly advancing retinopathy. The other was diagnosed as malignant nephrosclerosis but a

biopsy specimen of the kidney revealed an acute fulminating extracapillary glomerular nephritis. This was confirmed at necropsy. Seven were patients with essential hypertension with the possible exception of one in whom the biopsy specimen removed from the right kidney was strongly suggestive of pyelonephritis.

Postoperative Course.—The immediate postoperative period following the two types of kidney operations described varied in the different patients. In those with little or no kidney damage, recovery from the operation was uneventful. In two patients with relatively severe kidney lesions, there was marked postoperative distention, nausea and vomiting. Wound dehiscence took place in one instance. No pulmonary or cardiac complications were observed in spite of the use of general anesthesia (this form of anesthesia was employed because of the increased apprehension usually exhibited by these patients). There has been no fatality in the immediate postoperative period.

Clinical Observations.—Tables I to IV show the results obtained in the nine patients The preoperative and postoperative clinical status, and the postoperative blood pressures, are included in these protocols.

Effect upon the Heart.—The operative procedures described exerted no deleterious effect on the heart as determined by clinical and electrocardiographic studies

TABLE I

NEPHRITIS—RIGHT NEPHRO OMENTOPEXY

Case	No 1	No 2
Age and sex	38, M.	30, M
Clinical diagnosis. .	Chronic diffuse glomerular nephritis	Malignant hypertension
Duration of hypertension	2 years	9 months
Preoperative status		
Heart (EKG)	Not done	Normal
Kidney function ..	Urea clearance 30 per cent of average normal	Urea clearance 12 per cent of average normal
Kidney biopsy	Not taken	Acute diffuse extracapillary glomerular nephritis (subacute nephritis)
Fundus	Severe retinopathy	Severe retinopathy
Blood pressure (Av 10 days preop)	226/164	194/124
Postoperative blood pressure		
1 week	206/145	186/126
2 weeks. .	208/151	178/108
1 month . .	150/118	
Postoperative clinical status		
Subjective	Marked improvement first month postoperative	No change
Objective	Improved visual acuity Impairment in renal function not increased	Advancing renal insufficiency
Remarks	Died approximately 1½ mos postoperative during attack of acute paranoia Actual cause of death not known.	Died approximately 2 wks postoperative of retention uremia

Effect upon the Blood Pressure.—In patients with essential hypertension, unilateral (right) nephro-omentopexy was followed frequently by an appreciable fall in blood pressure for two to three months after the operation

(Cases 3, 4, 5 and 8, Table II; and Case 6, Table III) but within six months the blood pressure usually returned to the preoperative level. In one of the two patients with nephritis, a pronounced fall in blood pressure occurred for one month following unilateral nephro-omentopexy. This patient died one and one-half months postoperative, in a private sanitarium during an attack of acute paranoia; the exact cause of death was unknown (Case 1, Table I). Only two months have elapsed since the bilateral operations were carried out (Cases 6 and 7, Table III; and Case 9, Table IV). Obviously, insufficient time has elapsed to determine their effect, if any, on blood pressure.

TABLE II

ESSENTIAL HYPERTENSION—RIGHT NEPHRO-OMENTOPEXY

Case	No. 3	No. 4	No. 5	No. 8
Age and sex	51; M.	38; M.	44; F.	35; F.
Duration of hypertension	5 yrs.	6 yrs.	10 yrs.	3 yrs.
Preoperative status				
Heart (EKG)	T changes	Normal	T changes	Not taken
Kidney function	Normal	Normal	Normal	Normal
Intravenous urogram	Negative	Congenital anomaly right renal pelvis	Imperfect filling of right calices (pyelogram negative)	Negative
Kidney biopsy	Benign nephrosclerosis	Apparently normal	Strongly suggestive of pyelonephritis	Benign nephrosclerosis
Fundus	Moderately severe retinopathy	Mild retinopathy	Mild retinopathy	Minimal retinopathy
Blood pressure (Av. 10 days preop.)	232/144	192/123	200/116	202/122
Postoperative blood pressure				
1 mo.	198/118	202/142	158/102	
2 mos.	218/131	219/158	172/112	190/130
3 mos.	240/146		213/134	240/140
4 mos.	238/146		156/108	240/160
6 mos.			156/98	
7 mos.	250/130		230/124	
10 mos.	250/130		186/122	
11 mos.			192/118	
Postoperative clinical status				
Subjective	No improvement	No improvement	Moderate improvement. Vertigo and headaches have disappeared	Gained weight felt less irritable for 2 mos. postop.
Objective	Progressive mental deterioration	Attacks of acute abdominal pain	Decided improvement in eyegrounds	
Remarks	Eviscerated 14 days postop. Not known if omentum in apposition to kidney. Died in mental disease hospital 13 mos. postop.	Died 2½ mos. postop. from ruptured aneurysm of celiac axis.		Irritability, nervousness and headaches have now returned

Effect upon Renal Function.—Nephro-omentopexy and nephromyopexy were not followed by any measurable impairment in kidney function of a permanent nature. Occasionally, the urea clearance fell considerably in the immediate postoperative period; the return to the preoperative level, however,

was usually prompt. No evidence of improved renal efficiency was observed nor did these operations inhibit advancing renal insufficiency (Case 2, Table I; and Case 7, Table III).

Effect upon the Ocular Fundi.—Of interest was the report of the ophthalmologist (Dr. Martin Cohen) who believed two patients with essential hypertension presented less evidence of vascular damage in the fundi approximately three to four months after unilateral nephro-omentopexy (Case 5, Table II; and Case 6, Table III). In one patient, benign arteriolar sclerosis of the retinal vessels progressed to a severe retinopathy including papilledema, hemorrhages and exudates six months after right nephro-omentopexy (Case 7, Table III).

TABLE III

ESSENTIAL HYPERTENSION—RIGHT NEPHRO-OMENTOPEXY AND LEFT NEPHROMYOPEXY

Case	No 6	No 7
Age and sex	24, F	48, M.
Duration of hypertension	2 yrs	10 yrs
Status prior to right nephro-omentopexy		
Heart (EKG)	Normal	T changes
Kidney function	Normal	Normal
Intravenous urogram	Not definitely abnormal Pyelogram negative	Negative
Kidney biopsy (right)	Normal	Benign nephrosclerosis
Fundus	Mild retinopathy	Mild retinopathy
Blood pressure (av 10 days preop)	186/138	220/130
Blood pressure after right nephro-omentopexy		
1 mo.	150/108	225/130
2 mos	164/114	
3 mos.	182/134	187/122
4 mos	186/132	
5 mos.	186/138	
6 mos.	180/128	240/140
Clinical status after right nephro-omentopexy		
Subjective	Definitely improved. Rare headaches	No change
Objective	Decided improvement in eye-grounds	Advancing renal insufficiency. Eye-ground changes more pronounced
Interval between right nephro-omentopexy and left nephromyopexy	6 mos.	6 mos.
Status prior to left nephromyopexy		
Heart (EKG)	Normal	T changes more pronounced
Kidney function	Normal	Definite impairment Urea clearance 30 per cent of average normal
Kidney biopsy (left)	Normal	Severe nephrosclerosis
Fundus	Minimal retinopathy	Severe retinopathy
Blood pressure after left nephromyopexy		
1 mo.	176/128	
2 mos.	192/136	
Clinical status after left nephromyopexy		
Subjective	Feels very well	Nausea and vomiting
Objective	Condition excellent	Rapidly progressive renal insufficiency
Remarks		Died 18 days after left nephromyopexy of retention uremia

Subjective Manifestations.—Six of the nine patients in this series were relieved of most of their symptoms for two to 11 months following the operation. The relief from headaches and vertigo was particularly striking in four patients (Cases 5 and 8, Table II; Case 6, Table III; and Case 9, Table IV).

TABLE IV

ESSENTIAL HYPERTENSION—RIGHT NEPHRECTOMY AND LEFT NEPHROMYOPEXY

Case	No. 9
Age and sex	53; M.
Duration of hypertension	1½ yrs.
Status prior to right nephrectomy	
Heart (EKG)	T changes
Kidney function	Urea clearance 40 per cent of average normal
Intravenous urogram	Right renal lithiasis
Kidney pathology (right)	Nephrolithiasis, chronic pyelonephritis, and chronic ureteritis
Fundus	Mild retinopathy
Blood pressure (av. 10 days preop.)	221/121
Blood pressure after right nephrectomy	
1 mo.	170/106
2 mos.	226/124
3 mos.	240/134
4 mos.	218/134
Clinical status after right nephrectomy	
Subjective	Headaches and vertigo have disappeared
Objective	No improvement in renal efficiency
Interval between right nephrectomy and left nephromyopexy	4 mos.
Status prior to left nephromyopexy	
Heart (EKG)	No further changes
Kidney function	Urea clearance practically the same as prior to right nephrectomy
Kidney biopsy (left)	Lost
Fundus	Mild retinopathy
Blood pressure after left nephromyopexy	
1 mo.	254/150
Clinical status after left nephromyopexy	
Subjective	Improvement persists
Objective	Condition excellent

Postoperative Anatomic Status of the Kidneys.—Intravenous urograms carried out from two to six months after nephro-omentopexy showed (a) little or no distortion of the renal calices; (b) apposition of omentum to the kidney as revealed by the position of the brain clips; this was verified in two necropsies; and (c) occasional ptosis of the kidney of a moderate degree; this was not accompanied by angulation of the ureter or by any clinical manifestations.

SUMMARY.—An attempt has been made to increase the vascularity of the kidney in nine patients with arterial hypertension by means of nephro-omentopexy and nephromyopexy. The clinical and experimental basis for these operations, the operative approach and the postoperative course, are described in detail.

Unilateral nephro-omentopexy is frequently followed by an appreciable fall in blood pressure which persists for two to three months following the operation but, in most instances, within six months the blood pressure usually returns to the preoperative level. It is too early to make any statement concerning the effect upon the blood pressure of the bilateral operations (three patients), only two months having elapsed since these were carried out.

Six of the nine patients in this series were relieved of most of their symptoms for two to 11 months following nephro-omentopexy. The relief from headaches and vertigo was particularly striking in four of these. Improvement in the degree of retinopathy was observed in two patients; pro-

gressive retinal lesions were noted in one. Cardiac and renal functions were not affected adversely nor was any improvement in their respective efficiencies observed.

Addendum.—Since this paper was submitted for publication, four of the nine patients alive at the time this paper was first written have been followed for an additional 15 months. None of these has died. The effect upon the blood pressure of the bilateral operations has been disappointing. The results were not unlike those already described for the unilateral operations. Within three to six months after the second operation (Cases 6 and 9), the blood pressure again returned to the preoperative level, although subjective improvement has continued in one of these (Case 6).

Two reports have appeared in the literature which deserve mention. Abrami and his co-workers[10] have reported their observations in two patients with hypertension treated by nephro-omentopexy. Their results are not unlike those reported in this paper. Mansfield, Weeks, Steiner and Victor[11] have recently shown that in seven dogs rendered hypertensive by Goldblatt's technic, pexis between the kidney and omentum or spleen was followed by a lowering in blood pressure. The reduction in blood pressure was more sustained in dogs with splenic pexis than in those with omental union.

Acknowledgment.—Appreciation is hereby made to Dr. S. Milton Rabson of the Department of Pathology for his detailed reports on the renal pathology as revealed by the biopsy specimens and on the necropsy findings, to Dr. Martin Cohen for his studies on the ocular fundi; to Dr. Joseph A. Hyams for his urographic and pyelographic investigations; and to Drs. D. J. Dolan, D. S. Likely, I. S. Wright, and H. J. Wiener for their cooperation in the selection of the patients.

REFERENCES

[1] Goldblatt, H., Lynch, J., Hanzal, R. F., and Summerville, W. W.: Studies on Experimental Hypertension: (1) The Production of Persistent Elevation of Systolic Blood Pressure by Means of Renal Ischemia. Jour. Exper. Med., 59, 347, 1934; Goldblatt, H.: Studies on Experimental Hypertension: (V) The Pathogenesis of Experimental Hypertension Due to Renal Ischemia. Ann. Int. Med., 11, 69, 1937.

[2] Beck, C. S., and Tichy, V. L.: The Production of a Collateral Circulation to the Heart: (1) An Experimental Study. Am. Heart Jour., 10, 849, 1935; Beck, C. S.: Coronary Sclerosis and Angina Pectoris: Treatment by Grafting a New Blood Supply upon the Myocardium. Surg., Gynec., and Obstet., 64, 270, 1937.

[3] O'Shaughnessy, L.: Surgical Treatment of Cardiac Ischemia. Lancet, 1, 185, 1937.

[4] Pauntz, L.: Dauerversuch über die Ersetzung der Arteria renalis durch künstlich hervorgerufene Netzanastomosen. Ztschr. f. d. ges. exper. Med., 71, 321, 1929.

Ibid.: Die extraglomeruläre Vascularisation der Nierenrinde durch künstliche Netzanastomosen., 93, 366, 1934.

[5] Davis, H. A., and Tullis, I. F., Jr.: Studies in Renal Hypertension: (1) Experimental Production of Accessory Blood Supply upon Normal Kidney. Proc. Soc. Exper. Biol. and Med., 40, 161, 1939.

[6] MacNider, W. deB., and Donnelly, G. L.: Value of Omentopexy in Establishing an Adventitious Circulation in the Normal Kidney. Proc. Soc. Exper. Biol. and Med., 40, 271, 1939.

[7] Bruger, M., and Carter, R. F.: Evidence of Communication between Renal and Omental Blood Vessels Following Nephro-omentopexy for Arterial Hypertension in Man: Preliminary Note. Am. Jour. Med., Sci., 197, 832, 1939.

[8] Allen, E. V., and Adson, A. W.: Physiologic Effects of Extensive Sympathectomy for Essential Hypertension: Further Observations. Ann. Int. Med., 11, 2151, 1938.

[9] Hines, E. A., Jr., and Brown, G. E.: Standard Test for Measuring Variability of

Blood Pressure; Its Significance as an Index of Prehypertensive State. Ann. Int. Med., 7, 209, 1933.

[10] Abrami, P., Iselin, M., and Wallich, R.: Essai de traitement de l'hypertension artérielle d'origine rénale par la revascularisation chirurgicale du rein (néphro-omentopexie). Presse med., 47, 137, 1939.

[11] Mansfield, J. S., Weeks, D. M., Steiner, A., and Victor, J.: Reduction of Experimental Renal Hypertension by Pexis of Spleen or Omentum to Kidney. Proc. Soc. Exper. Biol. and Med., 40, 708, 1939.

MALIGNANT MELANOMA*

A CLINICAL STUDY OF ONE HUNDRED SEVENTEEN CASES

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FROM the clinical and pathologic points of view melanomata are among the most important of any malignant tumors, affecting persons of all ages. They are one of the most malignant growths and the results obtained from treating them are generally known as far from satisfactory. Therefore, a special study of treatment of these lesions with more favorable outcome seems justifiable.

This is a study and analysis of a group of malignant melanotic tumors treated by surgery and showing the results of such treatment over various periods ranging from a few months to 13 years. While the number of cases analyzed is comparatively small, the end-results, where radical surgery has been employed, compare very favorably with results in treating other types of nonmelanotic malignant tumors.

The Term Melanoma.—According to scientific records, obviously, Hippocrates mentioned the appearance of melanoma first, but one may safely assume that others noted it before him because of its characteristic color and course.

F. Müller gave this type of tumor the name of "carcinoma melanodes," and the term melanoma was first used by Carswell, in 1836, and by Virchow.[1] In this paper melanoma is used as a term applying only to essentially malignant tumors.

Pigmented Naevus.—According to Kumer,[2] 32 per cent of melanomata derive from a naevus (naevo carcinoma); therefore, a brief review of the origin, pigment formation, and known causes of malignant degeneration of this type of lesion is desirable.

The pigmented naevus is characterized by the presence of naevus cells in the corium which are more or less pigmented. Soldán,[3] 40 years ago, disclosed the nervous origin of the naevus clearly and convincingly. His work remained unnoticed until Masson,[4] 27 years later, identified his discovery and supported it with his own research. They demonstrated, without any doubt, that the naevi are the neuroma of the tactile end-apparatus (Wagner-Meissner and Merkel-Ranvier). The valuable research of Soldán[3] and Masson,[4] was confirmed by Foot.[6]

Laidlaw[7] drew a philogenetic parallel between the human and animal world, pointing out that, "the pigmented hairy mole appears to be a link or transition from pigmented tactile organs of the reptilian type to the hairy tactile organs

* Read before the Third International Cancer Congress, Atlantic City, N. J., September 11, 1939. Submitted for publication February 9, 1940.

of the mammalian type." Would this be the reversion to ancestral characteristics (atavism) like the development of supernumerary breasts[8] in the milk-line or at atypical locations; normally observed only in animals?

The formation of melanin pigment is probably a specific function of the basal cell layer of the rete malpighii. Melanin is supposed to be a pyrocatechol derivative closely allied to adrenalin. In animals, the mouth is often pigmented physiologically (for example, in dogs and cats). In human beings, pigmentation may be observed in the mouth in Addison's disease, lymphogranulomatosis, pediculosis, pernicious anemia, and malaria.

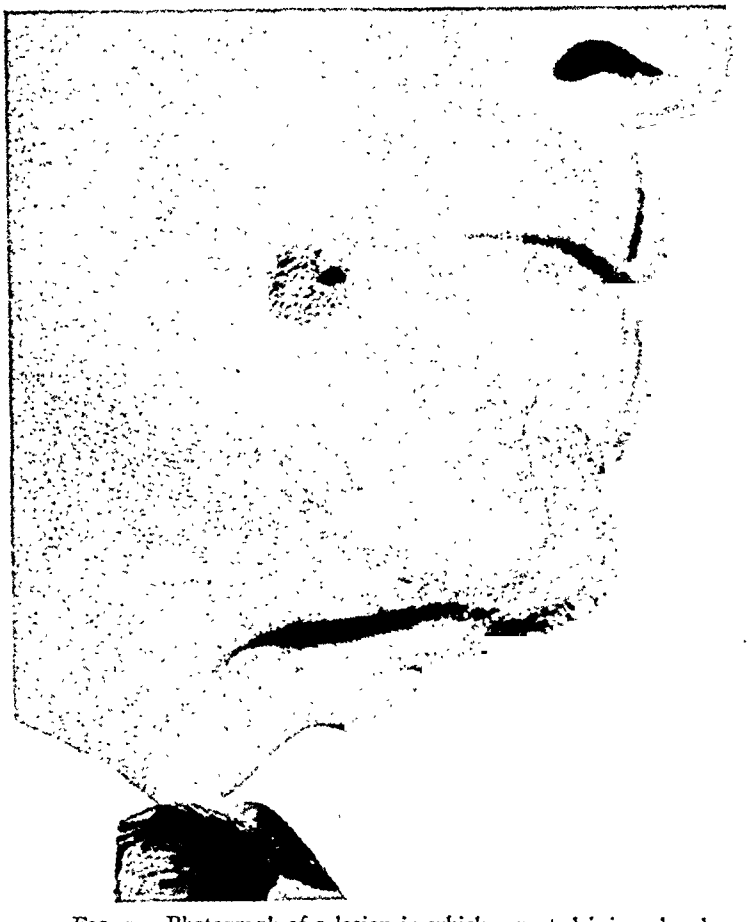


FIG. 1.—Photograph of a lesion in which repeated injury by shaving was most likely the inciting factor for the development of this malignant melanoma in a pigmented naevus. Wide local excision was performed. Patient is alive and well now for four years.

Etiology.—A melanoma often develops insidiously from a brown, black or bluish pigmented spot. Frequently, however, the wild proliferation of cells takes place after irritation or trauma, even from the unpigmented end-organs of the peripheral sensory nerves.[5] Repeated irritation over a period of years or following a single injury may be the cause, even in the very common mole with or without hair. The Cohnheim theory supposed that the pigmented mole harbors cells that are "sleepers" and after being irritated become actively growing melanoma. The cause may be friction by a corset on the back, or by the shoe in the nail bed (melanotic whitlow of Hutchinson), on the face after being cut by a razor (Fig. 1); even injection through a pigmented mole as in one of our cases seems to be the inciting cause.

Tièche[10] described a blue or bluish-black congenital macule located on the face, which is considered a persistent mongolian spot. The development of melanoma has occasionally been observed from this lesion. Infection of the surrounding skin areas of the naevus may be the irritating factor. The injudicious use of the electric needle (Fig. 2) in treating naevi was the most



FIG 2.—Hosp. No. J. 795: Photograph of a nonpigmented melanoma with axillary metastases, developing from a pigmented papillary naevus due to repeated irritation by electric needle. The treatment consisted of weekly desiccation over a period of 11 months. Female, age 36, died with general metastases in five months.

probable originator of melanoma in five of our cases (4.3 per cent), and in 10 per cent of the cases reported by Adair.[11] One of our patients used a corn-plaster on a congenital pigmented mole, giving rise to the development of melanoma. Trauma seemed to be the etiologic factor in 28 (25 per cent) of our cases. Daland and Holmes[16] found it in 24.8 per cent.

According to F. C. Lee,[12] Anglo-Egyptian Negroes have 100 times as many melanomata as American Negroes.[13] The reason, he ascribes, is that the wearing of shoes by the latter prevents the direct irritation of rough roads and thorns. Parkes-Weber[14] reported a newborn baby who died of liver metastases of melanoma, whose mother died, after giving birth, of generalized melanosis. He supposed that the metastasis occurred during the intra-uterine life through the placenta. The pigmented areas of xeroderma pigmentosum may give rise to melanomata, as was also observed in one of our cases.

Pathologic Classification.—From the clinical point of view melanomata have been classified as follows[15]:

(1) Naevus giving evidence of increase in size or in darkening of pigmentation.

(2) Melanoma showing well-developed tumor in local lesion.

(3) Melanoma with involvement of regional lymph nodes.

(4) Generalized melanoma—melanosis.

All of our cases were of Groups 2, 3 and 4.

Age Distribution.—The youngest patient with melanoma in our series was a 15-month-old girl, then a five-year-old boy. The oldest was a man of 78 years. Among the remaining patients there seems to be a fairly even distribution of melanomata between the ages of 20 to 70 years in both sexes. The most frequent occurrence was observed between the ages of 45 and 60, in which group 38 per cent of our patients were found. Table I shows the distribution of our 117 patients according to age:

TABLE I

AGE DISTRIBUTION

Years of age	1–10	10–20	20–30	30–40	40–50	50–60	60–70	70–80
No. of patients	2	8	19	20	23	29	13	3

The average age according to Hintze[16] is 47.7 years for males and 54.7 for females. Darier[17] states it to be 54.4 years for both sexes, while Butterwoth and Klauder[18] found it to be 49 years. Daland and Holmes[46] found their greatest number of cases in the sixth decade.

Statistics seem to indicate that women are affected somewhat more frequently.

Anatomic Distribution.—Melanomata may develop anywhere in the skin or, rarely, in mucous membrane. According to the analysis of our cases they are most common on the head (40 per cent), lower extremities (26 per cent), and upper extremities (15 per cent). According to the available computed figures, from the literature, melanomata are observed most frequently at the extremities (40.3 per cent: upper, 10.9 per cent; lower, 29.4 per cent). Properly speaking, the head lesions are the most frequent (35.1 per cent)—with the eye, 41 per cent, considered as one unit against four extremities. The remaining 24.3 per cent are scattered all over the rest of the body.

Melanomata have rarely been primarily observed at locations other than their usual appearance on the tegument. Peters reported five cases of melanoma observed in the male urethra. There have been fewer than 100 cases of melanoma of the rectum reported (Chisholm[21]). Lenče[22] collected 43 cases of primary melanoma of the central nervous system, in addition to one case of his own, also 11 cases in the biliary tract, and 39 cases in the oral cavity. They are seldom found in the nasal cavity, esophagus, or intestines. Tučzek[23] and Goldzieher[24] have described bilateral primary melanomata of the suprarenal glands.

Modes of Spread.—After the malignant changes have occurred in the tumor, they infiltrate the surrounding tissues, spreading first by *direct extension.* Handley[25] demonstrated the involvement of the lymphatic channels, which may result in the formation of numerous subcutaneous nodules proximally

or toward the periphery from the original growth. The tumor cells reach the *regional lymph nodes* through the skin lymphatics, causing their enlargement. It is rare to observe fungating lymph nodes because death occurs as the result of general metastases before this may happen. Pigmentation is often marked in the metastatic lymph nodes, even where the original lesion contained little or no pigment. The tumor gradually invades the capillaries of the invaded nodes, ruptures the blood vessels, and makes way for the invasion of the



FIG. 3.—Roentgenogram showing metastasis to the lower jaw from a malignant melanoma of the toe, which was cauterized, then excised by a chiropodist, later treated by an electric needle. Excision and resection of involved inguinal lymph nodes did not arrest the disease. Patient died three months later.

blood stream by the melanotic cells, which results in generalized metastases. Blood stream invasion may also occur directly.

Metastases—The Principal Organs Involved.—Among our cases, involvement of the regional lymph nodes at the time of the first examination was noted in 31 cases (27.4 per cent). Diffuse local, multiple involvement of the skin was present in two cases, and there were recurrent lesions in ten. Generalized metastases were observed in 11 cases, and these were considered inoperable (10 per cent).

Among Adair's[11] 400 cases there were 245 recurrent lesions, of which 141 were far advanced; he found only 26 per cent (that is, 105 cases) with primary tumors in operable condition.

According to Geschickter and Copeland,[26] bone metastases have been observed in only 1.07 per cent, which is about the same incidence as among our cases where we found only one metastasis of the lower jaw (see Fig. 3). This incidence, however, is possibly higher (Daland[46]).

Metastases usually appear in the regional lymph nodes of the drainage area. Lymph node metastases may occur early or it may appear only after the disease has become generalized. In generalized melanoma all organs may be involved. Diffuse and distant skin metastases are observed which vary in their course. Spontaneous regression[46] or sudden arrest of the evolution has been observed, which again may flare up with rapid growth. The liver is frequently invaded. The lungs, brain, heart, intestine, and the whole lymphatic system have been found involved.

Metastasis in the majority of cases appears within from six months to two years after the original tumor was noticed. It may, however, develop years after the original lesion has been removed or left untreated. In some cases the growth is slow and metastasis occurs late—in exceptional cases as late as from five to 15 years. Late, distant metastases are seen most often in the melanomata of the eye.[46] General metastases developed 27 years after operation in a case described by Balčerek.[27]

Symptomatology.—The first signs of the malignant proliferation are variable. It is common to observe that a hitherto symptomless naevus feels to the patient irritated, inflamed, and it may itch or even hurt slightly. It may ooze, weep or bleed, or adhere to the clothing. It increases in size, becomes more prominent, raised, and turgescent. A black spot may appear in the middle or at the periphery of the dark pigmented area (Fig. 1). The soft, cellular naevus becomes resistant, infiltrated, and firm. These changes are usually slow, taking several months; they are rapid only if irritation or trauma (especially if repeated) is the inciting factor.

Occasionally the original region is surrounded by small metastatic nodules which may be felt rather than seen. The lesion soon ulcerates, and becomes partly covered with a scab; it has the tendency to fungate and bleed easily. It is vegetant, gray-rose or dark red, and may be mistaken for a pyogenic granuloma. Regional lymph nodes are invariably enlarged after the disease advances. There can be no rule as to the time which has elapsed since the original lesion appeared. There seems to be no direct relation between the size of the tumor and the appearance of involved regional lymph nodes, which may occur earlier if ulceration has developed. General metastases may rarely occur simultaneously with regional lymph node involvement.

Melanuria, according to Kumer,[2] was present in 28 per cent of his cases. This may occur more often in the advanced lesions. The urine usually turns a darker color after standing in air, after the secreted melanogen becomes oxidized. Rarely, the urine is black from the secreted melanin.

There are some instances where the malignant degeneration of the pigmented mole is indicated by the enlargement of the regional lymph nodes,[15] and in some cases the original lesion may be so insignificant that it may not be detected even by careful investigation.

Time When Patients Apply for Treatment.—Less than 10 per cent of our patients came within one month following the first sign of malignant degeneration. The average time was eight months, which may be considered an unnecessary delay of six months, caused by lack of information or by fear.

Size of Melanomata.—Among our patients, at the time of applying for treatment, the size of the melanomata varied from 2 Mm. to 11 cm. in diameter. About 15 per cent of them had lesions measuring less than 1 cm. in diameter. The majority had lesions of from 1.5 to 2 cm. (55 per cent); the remaining 30 per cent had lesions averaging 3.5 cm. in diameter. No direct relation between the size of the lesion and regional lymph node involvement or general metastases could be established with any accuracy.

Clinical Types of Melanoma.—Usually, a melanoma is a flat or nodular, papillary, warty, raised lesion, but it may be a pedunculated, ulcerated, and less frequently a subcutaneous nodular lesion. It may be associated with neurofibromatosis or xeroderma pigmentosum. As has been mentioned, lymph node involvement may be the first symptom. Melanoma appears singly, and is seldom multiple.

Prognosis.—Melanoma is invariably fatal if not controlled by surgery or, possibly, by irradiation. It is not yet possible to depend entirely on the microscopic picture of the lesion regarding prognosis. General metastases occur more rapidly from an irritated lesion than from an untreated one. Some may live with untreated lesions for years, but the average duration of life is between one and one-half and three years. Younger people seem to die of the disease more quickly than do the more elderly.

A great number of patients who survive the five-year period develop recurrences later, and, according to Wilbur and Hartman,[28] all patients with melanoma of the eye die of general metastases (liver) if no other cause of death intervenes. One of our patients died six and one-half years after the operation, and one after 11 years from generalized melanoma.

Some recurrent lesions, however, may also be controlled and arrested by extensive radical surgery. Daland and Holmes[46] reported a patient with recurrent, diffuse, nonpigmented melanoma with inguinal lymph node involvement who, after the resection of the diffusely recurrent nodules of the thigh and leg, was well for six and one-half years.

Prophylactic Treatment.—Though the results obtained by surgery are encouraging, it seems to be equally important to prevent improper treatment or irritation of pigmented lesions. Collaboration between the public, practitioners, and surgeons is desirable with a view to eliminating those pigmented areas which may undergo malignant degeneration.

Beauty parlors, chiropodists, *etc.*, need to be warned about the possible consequences of insufficient treatment of the dark pigmented moles. It is

advisable to excise or coagulate those darkly pigmented naevi which are subjected to irritation (for example, by shoes, clothing, combing, and shaving). It is important to avoid the use of chemical irritations—caustics and electric methods which do not destroy the lesion in its entire extent.

FIG. 4 A

FIG. 4 B



FIG. 4 C

FIG. 5

FIG. 4 A.—Patient a 15-year-old girl: Malignant melanoma of three months' duration developing in a congenital naevus. Two months after local excision axillary lymph node dissection was performed. Several nodes were involved.

FIG. 4 B.—Local recurrence in ten months. Operative scar indicating previous excision and lymph node dissection in the axilla.

FIG. 4 C.—Good functional result after radical breast amputation for recurrence. Operative scar at the side of the chest indicates an electrosurgical excision for a third recurrence three months after radical operation. Prompt radical operation at the first intervention probably would have prevented repeated recurrences. Patient is well after one and a half years.

FIG. 5.—Path. No. S. C. 79660: Photomicrograph of tumor showing cells in distinct groups. Hyperchromatism and anaplasia. Dark brown pigment in many cells. (×570)

Pigmented moles occur at an average number of 20 on the body of each individual (Block[9]); therefore, it is easy to see how frequently intervention may be abused.

Especially dangerous, clinically, are the black, glistening or deeply pig-

mented moles; however, there are observations of numerous darkly pigmented moles which have been quiescent for an entire lifetime.

Surgical Treatment.—The generally accepted treatment is surgical. Early, radical excision alone gives satisfactory results at present, but dissection of the regional lymph nodes, even if there are none palpable nor enlarged, is advocated. In a melanoma of the breast of a 15-year-old female (Fig. 4 A), in whom, in spite of the fact that there were no palpable or axillary lymph nodes, dissection was performed, but pathologic examination showed secondary involvement with heavy pigmentation (Fig. 5). Although, one year later (Fig. 4 B), and, again, 18 months later, local recurrences developed. Removal of the breast, and wide excision of recurrent nodules, was undertaken. The patient has been well for the past 18 months (Fig. 4 C). Local recurrence may be more effectively controlled when there has been a previous lymph node dissection.

Administration of Coley's serum is disappointing, as is the use of colloidal lead (Adair[11]). Amadon[29] and Adair[11] condemned electrocoagulation, but Pfhaler and the French school[30] rely entirely upon it. At the Radiumhemmet in Stockholm, electrosurgery is recommended, followed by irradiation.[41] Recent literature advocates electrosurgery as the most effective method to treat local lesions.

In our opinion, wide, radical excision of the primary lesion with the underlying fascia and surrounding subcutaneous tissues including its lymphatic area, followed by regional lymph node dissection, is the choice of treatment. If biopsy is necessary to establish the diagnosis, it should preferably be accomplished by an electric loop, followed by coagulation of the lesion, in order to prevent dissemination.

Amputation is advocated in melanomata of the fingers, toes and foot, if lesion is on the heel (Fig. 6), for anatomic reasons where the connective tissue bands going from the skin perpendicularly to the underlying bone form closed spaces filled with fat tissue. This arrangement directs any inflammatory process or new growth formation toward the periosteum. The same thing happens in cases of pyogenic infection of the fingers, especially on the volar surface. The infection, if not drained, generally involves the tendon sheath, periosteum and bone. Therefore, melanomata of the fingers, toes and heels, presumably, can be effectively eradicated only by amputation followed by regional lymph node dissection.

Among the reported cases, amputation was performed in six instances followed by inguinal lymph node dissection, in which involvement was found in three cases. Of the 25 cases reported by Williams[31] (including eight non-pigmented melanomata) the only one which survived had had amputation performed.

Regional lymph node dissection appears to be indicated especially in lesions of the extremities (particularly the foot) where constant irritation seems to predispose to earlier lymph node involvement. Melanomata of the face would seem to have, therefore, a better prognosis, as they are treated earlier and are

less subject to trauma, which may delay regional lymph node involvement. Daland and Holmes[46] reported three cases surviving the five-year period; after the involved regional metastatic lymph nodes were dissected. Table II shows an analysis of our 24 cases with lymph node dissection:



FIG. 6.—Photograph of a malignant melanoma of the right heel of two years' duration. Previous cauterization. Excision by the high frequency current, followed by inguinal lymph node dissection failed to arrest the disease. Six months later, recurrent nodules were excised from the leg, then from the thigh. This patient, male, age 56, died one year after the operation. Lived three years with the lesion. Amputation might have been a life-saving procedure.

TABLE II

ANALYSIS OF 24 CASES WHICH HAD REGIONAL LYMPH NODE DISSECTION

16 cases with involved lymph nodes..... 62.5 per cent
8 cases with hyperplasia..... 37.5 per cent

SURVIVAL AFTER LYMPH NODE DISSECTION WITH INVOLVED NODES

2 cases —No follow-up
6 cases*—Died after average period of 2 years
1 case —Died after 6½ years
7 cases —Alive (2, for 6 months; 1, for 2 years; 1, for 3 years; 1, for 5 years; 1, for 9 years; and 1, for 11 years)

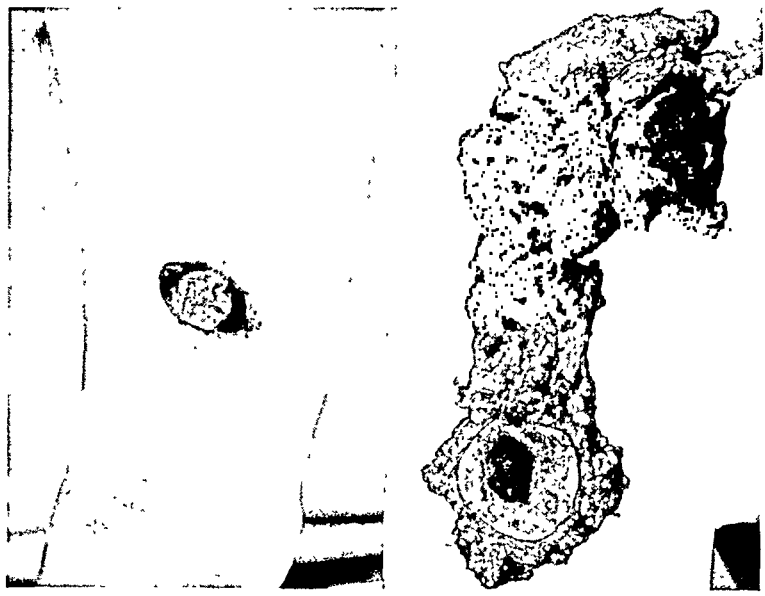
* Advanced lesions.

SURVIVAL OF CASES WITH HYPERPLASIA

1 case —No follow-up
1 case —Recurrence 2 years later
4 cases—Died (1, after 10 months; 1, after 1 year and 10 months; 1, after 2½ years; and 1 after 6½ years)
2 cases—Alive (1, after 8 months; and 1, after 3 years)

To prevent local recurrences, more radical surgery, according to the principles of Handley[25] and Pringle,[32] seems to be justified. This consists of a wide dissection of the lymph channels, not only around the lesion but also up to the nearest lymphatic nodes. The skin is reflected on each side between

the lesion and corresponding regional lymph nodes, and the subcutaneous tissue removed with the subcutaneous fascia in one continuous strip. A specimen (melanoma of the upper arm, obtained from an operation in accordance with this principle), is shown in Figures 7 A and B. With such a method, Pringle operated upon two cases—one, a woman with axillary lymph node involvement, who has been well for 38 years; and the other, a man with inguinal lymph node involvement, who has been well for 30 years. He further stated that these two were the only cases he had ever operated upon. How much the



A B

FIG. 7 A.—Photograph of a malignant melanoma of the right upper arm, with axillary lymph node involvement, which developed in a naevus. First sign one year previously.

B.—Gross specimen removed by wide incision, with surrounding subcutaneous fat tissue ad fascia, block dissection of lymphatics from lesion to axilla, and axillary lymph node dissection. One lymph node showed involvement (with heavy pigmentation).

In this advanced lesion even such a radical operation failed to arrest the disease. Patient died one year later of pulmonary involvement.

more radical approach will improve the result can be answered only in the future, after more experience and follow-up observation.

Roentgen Ray and Radium Therapy.—According to Adair,[11] irradiation is of questionable value, and Stewart[34] states that only 2 per cent of melanomata have some degree of radiosensitivity. Darier even states that roentgen ray and radium treatment is harmful. Francis Carter Wood expresses his belief in its inefficacy. Meland[35] states that roentgenotherapy may destroy the local lesion but that all the patients die of general metastases. Holfelder[36] treated 18 patients, 14 per cent of whom had previously been operated upon, and 40 per cent died within the first year. Chaoul[37] (using daily doses of 300 to 500 r to a total of 8 to 15,000 r) treated 14 cases, and failed in only two instances. However, only one case survived four years, and the majority less than one year. McEuen[38] reported two cases out of six, well over five years after radiotherapy.

We may conclude that irradiation under the present technic is not recommended as the sole treatment of melanomata, although one may conceive that early, localized lesions may be destroyed with heavy radiation, which of course may be more conveniently excised radically with better ultimate and cosmetic results.

Analysis of Available Material.—There were 117 cases available for study from the records of the Skin and Cancer Unit of the New York Post-Graduate Hospital. In these cases the clinical diagnosis of melanoma was made. Of this series, only 81 have been verified by pathologic examination.

Six cases were admitted with general metastases for palliative treatment. In these cases only biopsies were taken.

Operations were performed upon 75 patients.

There was no operative mortality. Among these 75 cases, there were 15 patients woh did not return for follow-up examinations. The analysis of these cases is shown in Table III:

TABLE III

ANALYSIS OF 81 HOSPITALIZED PATIENTS

Total No. of patients admitted to hospital		81	
Inoperable, biopsy only		6	
No. patients operated upon		75	92.5%
Operative Cases:			
Postoperative deaths	0		
Died (with follow-up)	24		
Alive (with follow-up)	36		
No follow-up (lost)	15		
Total	75		
Cases with Follow-Up;			
Alive (after from 3 months to 13 years)	36		
Dead (after from 6 months to 11 years)	24		
Total	60		

GROUP A.—TIME-PERIOD OF POSTOPERATIVE FOLLOW-UP OF 36 PATIENTS FREE OF RECURRENCE OR METASTASIS

5—	3 months:	Toe, ear, cheek, foot, forehead
5—	6 months:	Breast, arm, temporal region, 2 on the foot
5—	1 year:	2 foot, back, 2 eye
7—	1½ years:	3 cheek, scalp, 2 arm, foot
1—	2½ years:	Toe
3—	3 years:	Forehead, foot, arm
1—	4½ years:	Arm
1—	5 years:	Forehead
2—	8 years:	Cheek, back
1—	9 years:	Forehead
2—	10 years:	Arm
1—	11 years:	Lip
1—	12 years:	Arm
1—	13 years:	Arm

Summary of the above: Head, 16 cases; extremities, 16 cases; elsewhere, four cases.

GROUP B.—TIME-INTERVALS BETWEEN OPERATION AND DEATH OF 24 PATIENTS WHO DIED OF THE DISEASE

1	died in	6	months
1	" "	9	months
1	" "	1	year
3	" "	1½	years
4	" "	2	years
6	" "	2½	years
3	" "	3	years
1	" "	4	years
1	" "	4½	years
1	" "	4¾	years
1	" "	6½	years
1	" "	11	years

GROUP C.—CASES FOLLOWED FIVE YEARS OR MORE, INCLUDING FIVE CASES WHICH WERE NOT TRACED AS ASSUMED DEATHS

Postoperative deaths	0
Known deaths	10
Assumed deaths (cases lost)	5
Well without recurrence	9
Lived with recurrence, until death 6½ and 11 years after operation	2
Total	26

5-year survival—42.3%
10-year survival—19.2%

These statistics are given with the lost (not followed-up) five cases which are considered as dead.

None of our cases lived free of disease over the five-year period having melanomata on the foot. In one case it was on the toe, which was amputated after a recurrent lesion, but the patient died 11 years later. Therefore, according to our small series of cases, we may reaffirm our previous statement that these malignant pigmented lesions are more benign in their clinical course on the head than when situated on areas such as the foot, where they are subjected to more trauma.

Among the patients in Group C, five had regional lymph node dissection; three of these five have survived for eight, nine and 11 years, respectively, with no evidence of disease, in spite of the fact that the regional lymph nodes were secondarily involved.

Five patients have been well for over ten years (one each for 13, 12, and 11 years, and two for ten years), one for nine years, two for eight years, and one for over five years. One died from general metastases 11 years after operation, following a symptomless period of eight years, and another died suddenly with general metastases after six and one-half years.

Statistics from Other Authors.—Darier[17] reported 43 cases, with follow-up on 23 of them. He employed electrosurgery, and had nine patients living for periods ranging from one to 12 years after operation. Miescher and Schurch[19] reported on 41 cases of melanomata on the head and extremities, treated by surgery and electrosurgery, and stated that 19 patients survived for periods varying from one to 11 years after operation (Table IV).

TABLE IV

SUMMARY OF CASES REPORTED BY OTHER AUTHORS WITH DEFINITE ARREST OF THE DISEASE FOR FIVE YEARS OR LONGER

Reported by	No. of Cases	Location of Lesion	Kind of Therapy	Survival		Percentage of 5-Year Arrest	Percentage over 10 Years
				No. of Cases	Time		
Adair[11]	70	Head, body and extremities	Surgery	23	5 yrs.	33	
Affleck[20]	170	Head, body and extremities	Surgery	20	5 yrs.	11.1	
Bloodgood[39]	200	Head, body and extremities	Surgery	1	5 yrs.	0.5	
Daland and Holmes[16]	82	Eye, head, body, and extremities	Surgery	15	5 yrs.	18.3	
de Cholnoky	26	Eye, head, body, and extremities, except eye	Surgery	11	5 yrs.	42.3	
				5	10 yrs.		19.2
Gleave[10]	18	Eye	Surgery	9	5 yrs.	50	
				5	15–19 yrs.		27
Hintze[16]	54	Head, body and and extremities	Surgery and x-ray	15	5 yrs.	27	
				5	13 yrs.		9.2
Meland[35]	50	Head, body and extremities	Surgery	9	5 yrs.	18	
Scharnagel[41]	70	Head, body and extremities	Electro-surgery and x-ray	27	5 yrs.	39	
Scott[42]	53*	Head, body and extremities	Electro-cautery	11	5 yrs.	37.9	
Total	793			156			
Average per cent of five-year arrest						19.2	

Differential Diagnosis.—Differentiation of melanoma from epithelioma is not difficult if pigmentation is present. The classic symptoms are well known. However, as Ewing has pointed out, there are pigmented epithelial tumors that are not identical with melanomata, and it is sometimes difficult to distinguish between them. These lesions are the pigmented epithelial papillomata, pigmented basal cell tumors, pigmented carcinoma in xeroderma pigmentosum.

Ulceration of the nail bed should be regarded with suspicion, especially above the age of 40, according to Womack.[43]

Ulcerated hemangiomata, warts, frequently granulation tissue, and above all pyogenic granuloma may closely simulate rapidly growing melanoma of the skin and mucous membrane. According to MacKee and Cipollaro,[44] the pyogenic granulomata, sometimes dry but mostly with mucopurulent exudate present, are soft (boggy), of various shades of red, often encrusted, and vary in diameter from 2 Mm. to 1 cm. They bleed readily and may be pedunculated. Melanomata grow relatively slowly; they are firmer, and discharge only if ulceration is present. Often, there is a history of an antecedent naevus with more or less pigmentation.

Histologic examination should confirm the diagnosis.

Nonpigmented Melanomata.—These are only rarely diagnosed clinically (3 per cent of our cases). The absence of pigment may be explained by their rapid growth—with bad prognosis. These melanomata are observed in patients past middle life. More than 50 per cent of them are at the lower extremi-

ties. Horwitz,[45] among his 49 cases, found that their life average was 18.8 months, and that the postoperative arrest in 10 per cent of his cases ranged from two weeks to six and one-half years. Of his cases, 80 per cent died in from seven to 25 months (average, 16.8 months) when only irradiation was resorted to (six cases). Of eight cases, in which surgical excision was followed

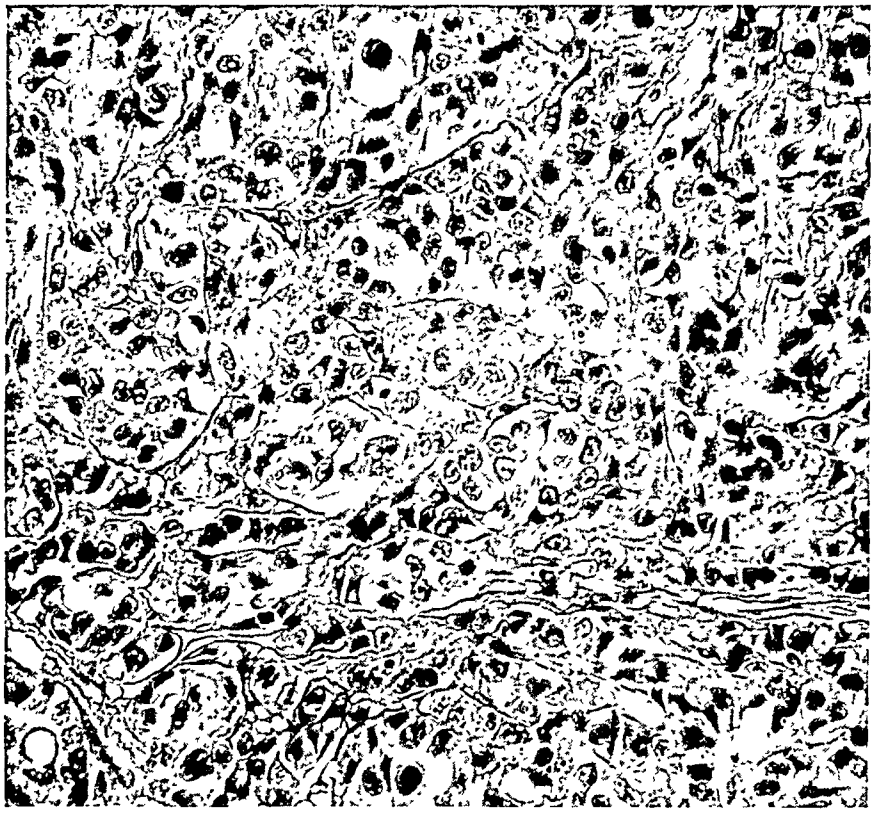


FIG. 8.—Path. No. S. C. 18683: Photomicrograph of a nonpigmented melanoma beneath skin of sole of foot. Female, age 68. Duration one year. (×250)

by roentgen ray and radium therapy, three were alive (for two years and 11 months, three years and eight months, and five years and nine months after operation).

Among our cases, there was a 55-year-old female with a nonpigmented melanoma. In this case, after amputation had been refused, 30 superficial, recurrent lesions were removed by an electric loop, at nine different intervals. The duration of the disease from beginning to end was three years. Only after two years was a lesion noted at the popliteal region, followed by others along the lymphatic path at the middle of the thigh within six weeks. The inguinal lymph nodes were involved for only a few months before the disease became generalized. Apparently, the tumor was spreading through the lymphatics of the subcutaneous tissues, and it could be clearly observed, clinically, that its propagation followed the lymphatics before the disease became generalized.

The study of this case and others suggest that amputation might have been a life-saving procedure.

SUMMARY AND CONCLUSIONS

Melanomata are pigmented or nonpigmented tumors of the skin and mucous membrane, supposedly of nervous origin. These extremely malignant lesions frequently arise from pigmented moles. They are observed at all ages, but predominantly between 45 and 60 years, and in both sexes.

Trauma and chronic irritation are evident in their development, as etiologic factors, in 25 per cent of cases. Lack of information is responsible for the fact that patients apply for late treatment. In the majority of cases there is an average of six months' delay. Since we are dealing with a superficial lesion that is easily discoverable, this dangerous delay could be prevented by disseminating information to the laity. Prophylactic treatment is advocated.

A clinical study and analysis of 117 cases of malignant melanoma are reported. Modes of spread, metastasis, symptomatology and prognosis are discussed.

Roentgen ray and radium therapy may destroy a local lesion, but authenticated cures under this treatment are rare; therefore, in operable cases it is not recommended in its present form.

In destroying the local lesion, electrocoagulation followed by lymph node dissection may be a desirable procedure.

In our opinion, radical surgery is the treatment of choice, and should consist of wide local excision including surrounding subcutaneous fat tissue and underlying fascia, followed by regional lymph node dissection. More radical intervention, consisting of removal of the lymphatic vessels in the subcutaneous fat tissues around the lesion and between the lesion and the regional lymph nodes, may also be desirable in irritated lesions. Amputation of the fingers, toes, and foot is advocated for anatomic reasons. This may give us improvement of the percentage of "five-year arrest," which to-day occurs in about one-third of the cases. The author's statistics of a relatively small number of cases show five-year arrest in 42.3 per cent, and ten-year arrest in 19.2 per cent of the cases; not including the cases untraced which are reported as deaths. In the New York Skin and Cancer Unit of the New York Post-Graduate Hospital, the tendency is to undertake radical surgery in treating melanomata.

The author wishes to acknowledge the kind cooperation of Dr. D. S. D. Jessup, Associate Consulting Pathologist of the New York Post-Graduate Hospital, who not only reviewed the slides of the cases studied but also gave many valuable suggestions in the preparation of this paper.

DISCUSSION.—Dr. D. S. D. Jessup (New York): There are some features of the pathology of melanotic tumors which are in contrast to the course pursued by other malignant tumors:

(1) The small and often insignificant size of the primary growth: One of our last treated cases had a tumor of short duration, 1 cm. in size, on the toe, which had already metastasized to the inguinal nodes. Another tumor, 3x5

Mm., under the nail bed of a finger, present for two months, showed invasion of the axillary nodes.

(2) The relatively benign appearance of the tumor cells in many melanomata: There are very few if any mitoses, anaplasia is absent, and in bleached sections, after removal of the pigment, the tumor appears relatively benign compared to what we are accustomed to see in metastasizing carcinoma or anaplastic sarcoma.

(3) In the metastases, we often find mere streaks of pigment in small cells as the only indication that the tumor is spreading from its primary site.

(4) Naevocarcinoma: While many believe that a large percentage of melanocarcinomata develop from pigmented naevi, it has been very seldom that we have been able to find traces of naevus cells alongside the developing melanocarcinoma. There is often the history of a pigmented birthmark but many of the deeply pigmented flat growths contain no naevus cells and show only pigmented cells in the corium. Where such pigment is deep in the corium we have the blue naevus, and if it is in the sacral region, the mongolian spot. Such pigmented areas may develop into melanocarcinoma, but we have followed many of the cases for years after removal of the tumor and they have shown no tendency to recurrence or spread. There does not seem to be any distinguishing feature in these flat melanomata which enables us to say whether they are potentially malignant. We see remains of flat melanomata alongside of more recent melanocarcinoma developing in the melanomatic bed, and we cannot differentiate the remains of the original growth from the clinically benign melanomata which have been treated by simple excision, and followed for years.

(5) Treatment: In following these treated cases for years, we have been impressed by the fact that surgery proves effective, often for long periods, and that regional node block dissections should be employed in the same way as in other forms of metastasizing carcinomata.

REFERENCES

[1] Virchow, R.: Die Krankhaften Geschwülste. Vol. 2, Berlin, 1864.

[2] Kumer, Leo, and Lang, F. J.: Die bösartigen Geschwülste der Haut. Haut und Geschlechtskr., 2, 829, 1934; and Melanoma. *Ibid.*, pp. 942–962.

[3] Soldán, R. L.: Über die Beziehungen der Pigmentmähler zur neurofibromatose. Arch. f. klin. Chir., 59, 261–296, 1899.

[4] Masson, P.: Les naevi pigmentaires, tumeurs nerveuses. Ann. d'anat. Path., 3, 417–453, 1926.

[5] Ewing, F.: The Problems of Melanoma. Brit. Med. Jour., 11, 852–856, 1930.

[6] Foot, N. C.: Concerning the Histology of Melanoma. Am. Jour. Path., 8, 309–327, 1932.

[7] Laidlaw, G. F., and Murray, M. R.: Melanoma Studies. Am. Jour. Path., 9, 827–838, November, 1933.

[8] Cholnoky, T. de: Supernumerary Breasts. Arch. Surg., 39, No. 6, 926–941, December, 1939.

[9] Bloch, B.: Das Pigment. In Jadasson, J.: Handb. der Haut- und Geschlechtskr., Berlin, J. Springer, 1, 434–533, 1927.

[10] Tièche, Max: Über benigne Melanome der Haut. Virchows Arch. f. path. Anat., 186, 212–229, 1906.

[11] Adair, F. E.: Treatment of Melanoma: Report of 400 Cases. Surg., Gynec., and Obstet., 62, 406–409, 1936.

[12] Lee, F. C.: Melanoma. Surg. Clin. North America, 16, 1439–1448, October, 1936.

[13] Hewer, T. F.: Malignant Melanoma in Colored Races: The Rôle of Trauma in Its Causation. Jour. Path. and Bact., 41, 473–477, 1935.

[14] Parkes-Weber, F., *et al.*: Spontaneous Inoculation of Melanotic Sarcoma from Mother to Fetus. Brit. Med. Jour., 1, 537–538, 1930.
[15] Dawson, J. W.: The Melanomata, Their Morphology and Histogenesis. Edinburgh Med. Jour., 32, 509–715, 1925.
[16] Hintze: Die Heilung des Melanosarkoms durch R.-und Radiumbehandlung. Zentralbl. Hautkrankheiten, 33, 147–148, 1930.
[17] Darier, J.: Melanoses, Melanomes et Melanosarcomes. Bull. Soc. franç. de dermat., 7, 23, 1925.
[18] Butterworth, T., and Klauder, T. V.: Malignant Melanomas Arising in Moles. J.A.M.A., 102, 739–745, 1934.
[19] Miescher, G., and Schürch, O.: Zur Behandlung der bösartigen Melanome. Deutsch. Ztschr. f. Chir., 241, 633–653, 1933.
[20] Affleck, D. H.: Melanomas. Am. Jour. Cancer, 27, 120–138, 1936.
[21] Chisholm, A. J.: Melanosarcoma of Rectum. Colorado Med., 34, 570–572, 1937.
[22] Lenče, P.: Über seltene primäre Lokalisationen melanotischer Tumoren. Ergebn. d. allg. Path. u. path. Anat., 32, 48–90, 1937.
[23] Tučzek, K.: Über die Beziehungen der Nebennierenpigmentation zur Hautfarbe mit besondere Berucksichtigung der pigmentierten Nebennierentumoren. Beitr. z. path. Anat. u. z. allg. Path., Jena, 58, 250–272, 1914.
[24] Goldzieher, M.: Demonstration soltener Geschwülste. Verhandl. d. deutsch. path. Gesellsch., Jena, 16, 213–220, 1913.
[25] Handley, W. S.: Recurrent Melanotic Sarcoma. Tr. Med. Soc., London, 47, 17, 1923–1924.
[26] Geschickter, C. F., and Copeland, M. M.: Tumors of Bone. Internat. Surg. Digest, 10, 323–343, December, 1930.
[27] Balčerek, H.: Multiple intrathorakale Metastasen nach maligner Degeneration einer Naevus pigmentosus. Berl. klin. Wchnschr., 58, 1327, 1921.
[28] Wilbur, L. D., and Hartman, H. R.: Malignant Melanoma with Delayed Metastatic Growth. Ann. Int. Med., 5, 201–211, 1931.
[29] Amadon, P. D.: Electrocoagulation of the Melanoma and Its Dangers. Surg., Gynec., and Obstet., 56, 943–946, 1933.
[30] Ravaut, P., and Ferrand, M.: Le traitement des naevocarcinomes par la diathermocoagulation. Bull. Soc. franc. de dermat. et syph., 34, 96–105, February, 1927.
[31] Williams, I. G., and Martin, L. C.: Naevocarcinoma of Skin and Mucous Membranes. Lancet, 1, 135–138, 1937.
[32] Pringle, J. H.: Cutaneous Melanoma; Two Cases Alive 30 and 38 Years after Operation. Lancet, 1, 508–509, 1937.
[33] Prud'homme, E.: Naevocarcinomatose généralisée et venim de cobra. Jour. de l'Hôtel-Dieu de Montréal, 4, 372–378, 1935.
[34] Stewart, F. W.: Radiosensitivity of Tumors. Arch. Surg., 27, 979–1064, *Ibid.*, December, 1933. Melanoma, pp. 1053–1054.
[35] Meland, O. N., and Lindberg, L.: Malignant Melanoma; Course and Treatment. Southwestern Med., 20, 336–346, 1936.
[36] Holfelder, H.: Welche Behandlung bietet die beste Heilungaussicht beim Melanosarcoma. Röntgenpraxis, 1, 19–27, 1929.
[37] Chaoul, H., and Greineder, K.: Die Behandlung des malignen Melanoms mit der Röntgen-Nahbestrahlung. Strahlentherapie, 56, 40–49, 1936.
[38] McEuen, H. B.: Report of Six Cases of Malignant Melanoma Treated with X-ray Radiation; with Two Cases Cured for Over Five Years. Radiology, 14, 587–590, 1930.
[39] Bloodgood, J. C.: Excision of Benign Pigmented Moles. J.A.M.A., 79, 576, 1922.
[40] Gleave, H. H.: Prognosis in Malignant Melanoma. Lancet, 2, 658–659, 1929.
[41] Scharnagel, T.: Treatment of Malignant Melanomas of the Skin and Vulva at the Radiumhemmet, Stockholm, Acta Radiol. (Stockholm), 14, 473–490, 1933.

[42] Scott, A. C.: Five-Year Cures of Cancer of Breast and of Melanoma. Surg., Gynec., and Obstet., 60, 465–466, 1935.
[43] Womack, N. A.: Subungual Melanoma. Arch. Surg., 15, 667–676, 1927.
[44] MacKee, G. M., and Cipollaro, A. C.: Cutaneous Cancer and Precancer. New York, Am. Jour. of Cancer, 1937.
[45] Horwitz, A.: Melanotic Tumors. ANNALS OF SURGERY, 87, 917–933, 1928.
[46] Daland, E. M., and Holmes, Joseph A.: Malignant Melanomas, New England Jour. Med., 220, 651–660, 1939.

SMOKING AND THROMBO-ANGIITIS OBLITERANS*

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TOBACCO SMOKING is so frequently associated with acute thrombo-angiitis obliterans that it is generally considered an important causative factor of the disease. The way smoking acts as a contributing or as an exciting cause is not known but it is essential for the success of treatment and the avoidance of recurrences that smoking be discontinued. Recent investigations[1] of the effect of tobacco upon the blood pressure, pulse rate and skin temperatures have demonstrated the same response in patients with thrombo-angiitis obliterans as in normal controls. Maddock and Coller[2] reported "comparatively analogous changes" from the pharmacologic action of intravenous nicotine. Hypersensitivity to tobacco[3] is not a factor in thrombo-angiitis obliterans and our results[4] with allergy tests did not confirm reports[5, 6] of increased sensitivity to tobacco.

Since almost all patients with thrombo-angiitis obliterans are cigarette smokers, it seemed to us that the changes in "The Blood in Thrombo-Angiitis Obliterans," which we recently reported,[7] might be the result of smoking. The blood changes were found in the acute, active stage of the disease. Not only was an excessive amount of tobacco being consumed, but inhalation of the smoke was unusually deep and frequent. The present study was made to determine the effect of smoking on the arterial and venous blood and the apparent physiologic responses.[8, 9, 10, 11, 12] No attempt was made to compare the various brands of cigarettes or the ingredients of the tobacco.

METHOD OF INVESTIGATION.—All patients were stabilized in bed at room temperature for one hour with the body and extremities covered by one sheet. Repeated observations were made on the blood pressure, pulse rate, respiratory rate and the skin temperature of the toes and fingers. Arterial blood was obtained from the right radial artery and venous blood from the right antecubital vein. The methods for collecting and analyzing the blood were the same as used in our previous work.[7]

After the period of stabilization and initial observations, the various procedures were followed with and without vascular puncture. Successive cigarettes were smoked at 15 minute intervals.

RESULTS.—*Peripheral Skin Temperature.* In a series of 14 normal control patients, the average decline in temperature of the toes was 2.8° C. and

* Read before the Chicago Surgical Society, November 2, 1939. Submitted for publication June 26, 1939.

of the fingers 3.9° C. (Table I). With the smoking of successive cigarettes the temperatures frequently continued to drop until a level was reached which remained unchanged by further smoking, or which, as noted in Chart 1, returned to the initial level despite the continuation of smoking. In general, the most marked reduction in temperature occurred in normal, moderate smokers and not in the patients with neurocirculatory disease or in non-smokers.

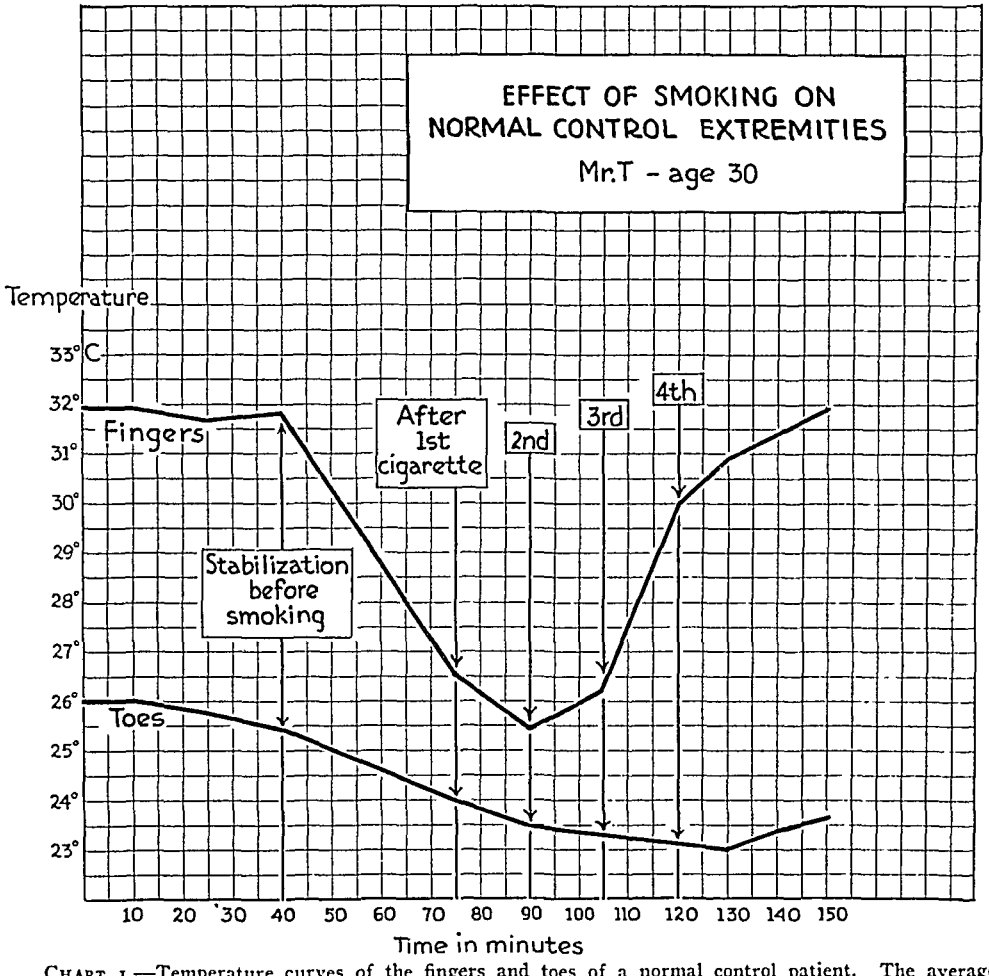


CHART 1.—Temperature curves of the fingers and toes of a normal control patient. The average temperature of the fingers dropped 6.4° C. after smoking one cigarette but returned to the presmoking level despite the continuation of smoking.

The response to smoking in patients with thrombo-angiitis obliterans varied with the stage of the disease and the amount of tobacco still being consumed. The skin temperature was reduced in 11 cases and elevated in eight cases. Although maximum declines in the temperature of the toes of 1.6° C. and of the fingers of 2.6° C. are shown in the table, these more normal changes occurred in clinically improved or recovered cases. These patients had some vasomotor response with novocain nerve block.[13]

The mechanism of reduction of the peripheral temperature is not entirely due to sympathetic control of the peripheral vessels. In Raynaud's disease,

TABLE I

CHANGES IN SKIN TEMPERATURES OF FINGERS AND TOES FOLLOWING SMOKING

	No. of Cases	Toes			Fingers		
		Max.	Min.	Average	Max.	Min.	Average
Normal controls							
Decreased temperatures	14	−4.0° C.	−0.1° C.	−2.8° C.	−6.4° C.	−0.1° C.	−3.9° C.
Increased temperatures	2	+0.2° C.	+0.1° C.	+0.2° C.	+0.3° C.	+0.1° C.	+0.2° C.
Peripheral circulatory disease							
Thrombo-Angiitis Obliterans:							
Decreased temperatures	11	−1.6° C.	−0.1° C.	−0.4° C.	−2.6° C.	−0.3° C.	−0.7° C.
Increased temperatures	8	+1.5° C.	+0.1° C.	+0.6° C.	+0.6° C.	+0.1° C.	+0.2° C.
Nonthrombo-Angiitis Obliterans:							
Decreased temperatures	8	−2.3° C.	−0.1° C.	−1.8° C.	−4.3° C.	−0.3° C.	−2.6° C.
Increased temperatures	2	+4.3° C.	+0.3° C.	+2.0° C.	+1.1° C.	+0.1° C.	+0.5° C.

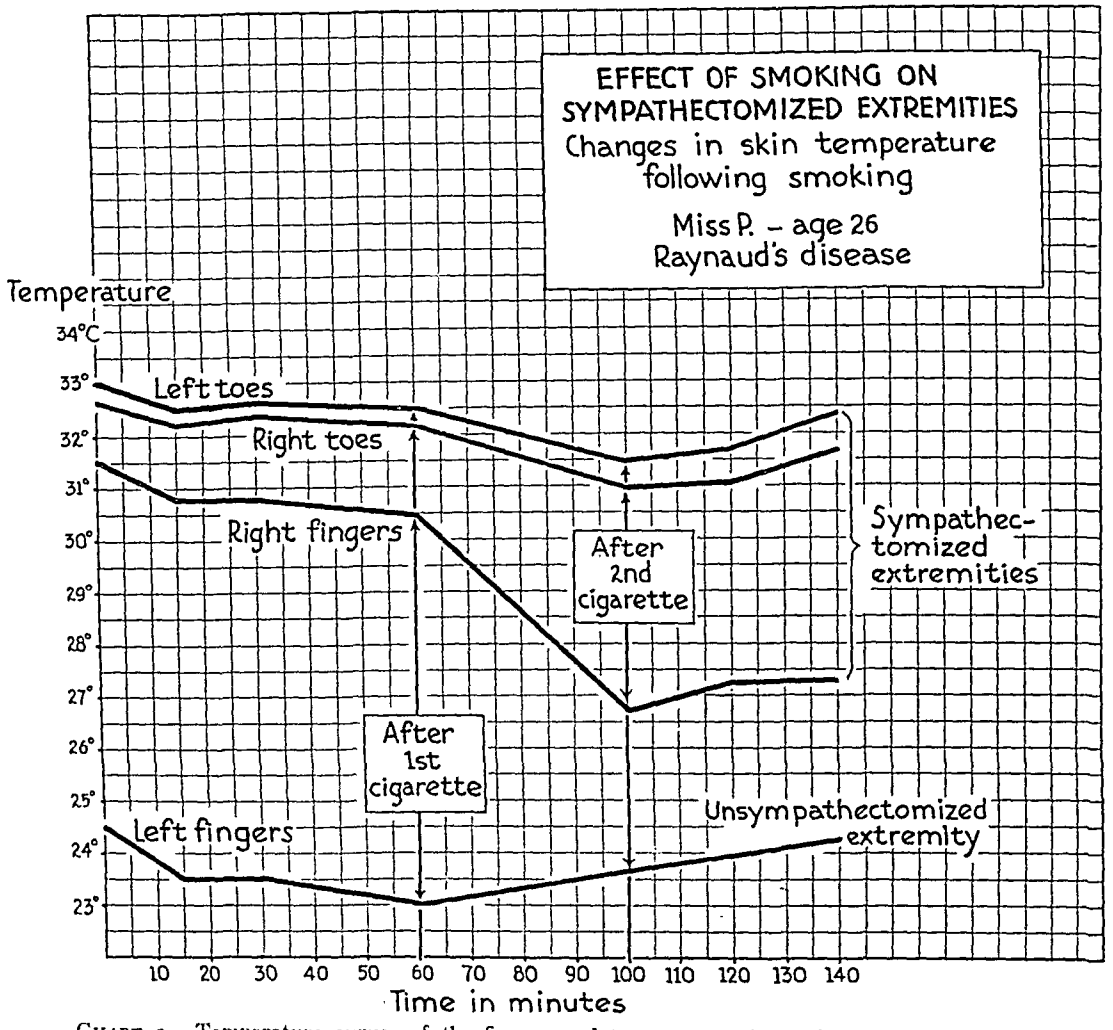


CHART 2.—Temperature curves of the fingers and toes on a patient with Raynaud's disease. The right upper and both lower extremities were sympathectomized and the left upper extremity was unsympathectomized. Note the marked reduction of 4.8° C. in the average temperature of the fingers of the sympathectomized right upper extremity after smoking one cigarette.

the sympathectomized extremities had an average decline in temperature of the fingers of 4.0° C. and of the toes of 1.5° C. (Chart 2) after smoking one cigarette. The left upper extremity was unsympathectomized. Smithwick, Freeman, and White[14] reported a similar response to adrenalin in sympathectomized extremities. The peripheral temperature response to smoking is due to changes in the circulating blood in addition to the central vasomotor control of the blood vessels.

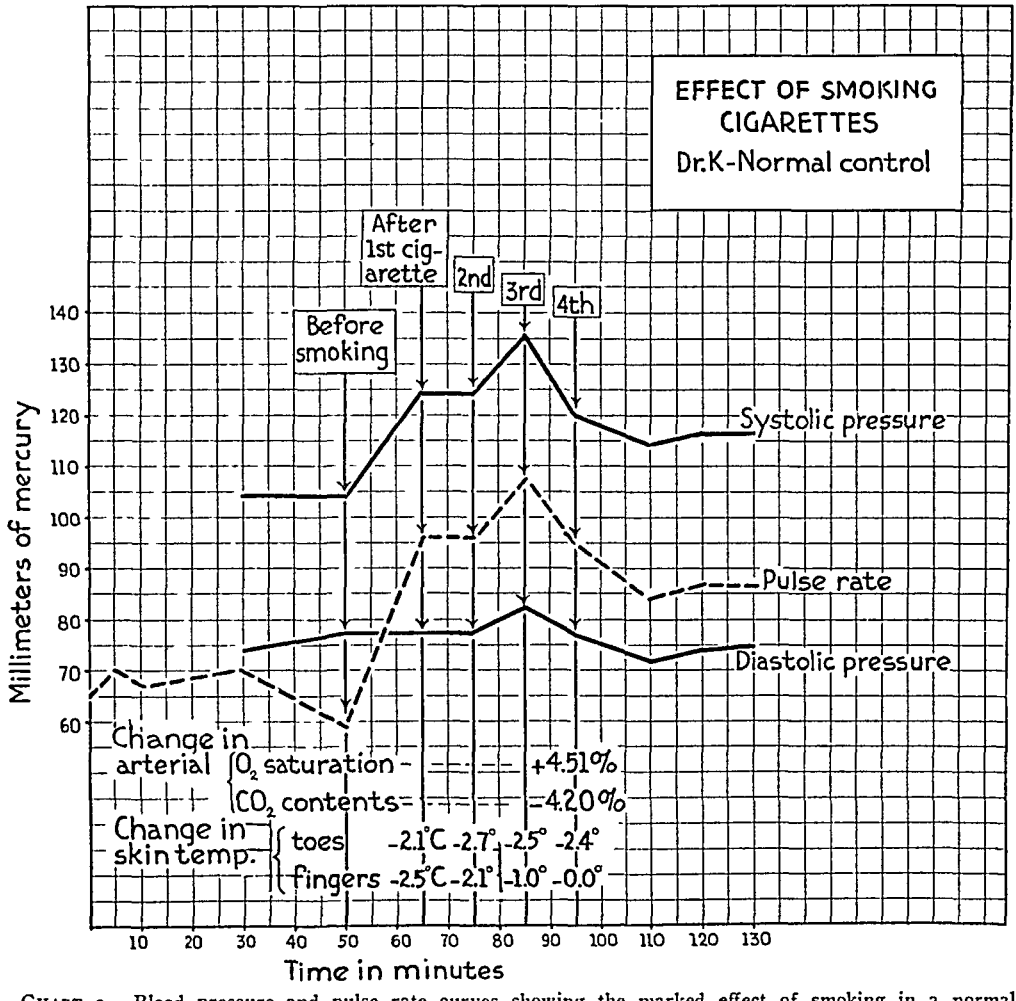


CHART 3.—Blood pressure and pulse rate curves showing the marked effect of smoking in a normal control patient which was accompanied by a 4½ per cent increase in oxygenation of the arterial blood.

Blood Pressure.—In the normal controls, smoking produced an elevation in pressure which was proportional to the initial readings and the number of cigarettes recently consumed. Low initial readings were usually obtained when smoking had been curtailed or discontinued. These patients showed the most marked but temporary elevation to the few cigarettes used in the test (Chart 3). High initial systolic pressure (160 to 180 Mm.Hg.) was occasionally found in heavy smokers and these patients had little, if any, response to the smoking test (Mr. P. Table V).

Patients with inactive thrombo-angiitis obliterans reacted in the same way as the normal controls (Charts 4 and 5). During the acute stage of the disease, all patients had systolic pressure of 115 to 135 Mm.Hg. After recovery when heavy smoking was resumed there was a gradual rise in pressure, and if smoking was not resumed the pressure dropped, in one case from 125 to 98. The blood pressure level seems to depend upon the adjustment of the body to the effects of smoking. It is significant that an acute attack of

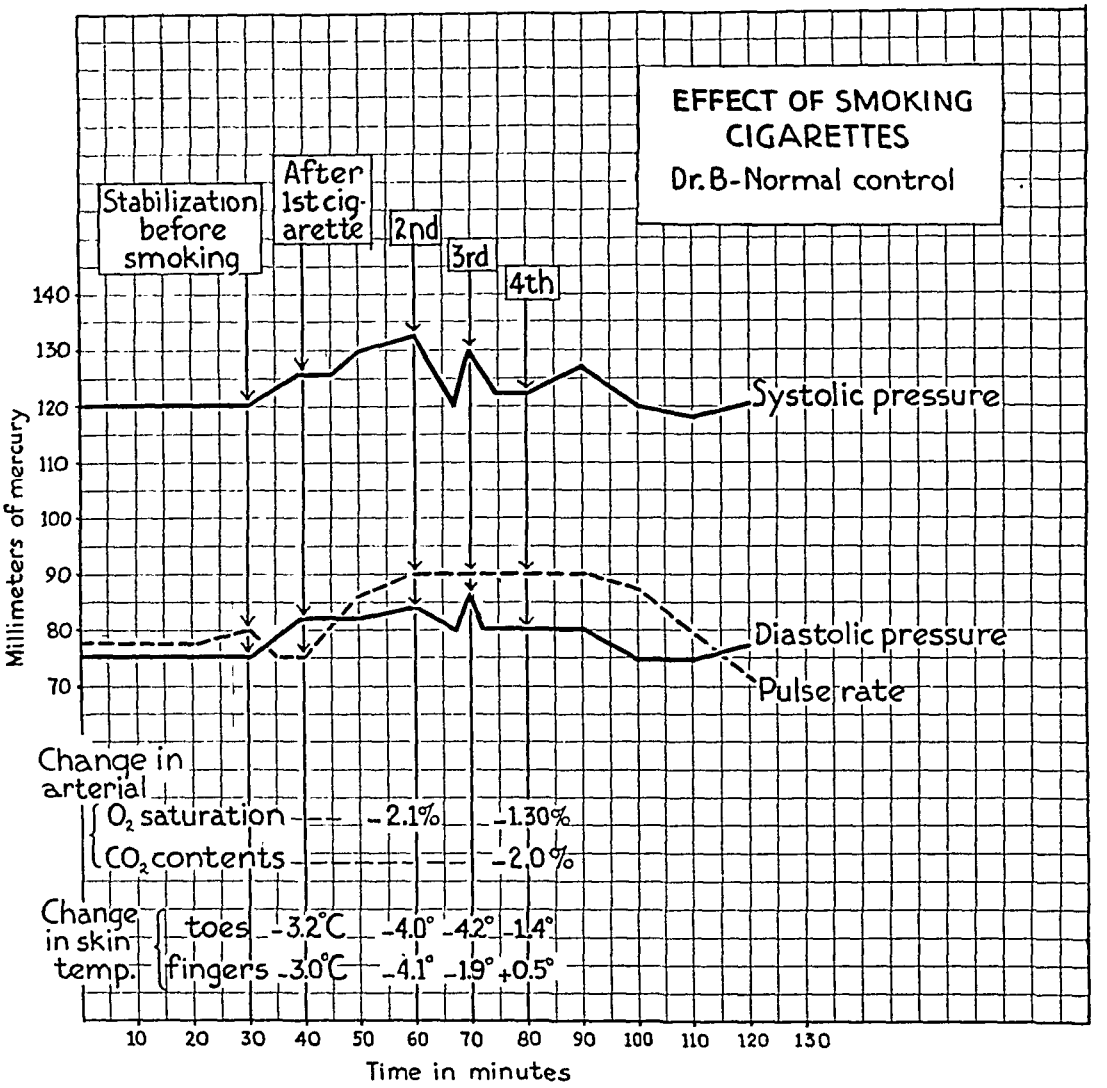


CHART 4.—Blood pressure and pulse rate curves of a normal control patient with 2 per cent reduction in the oxygenation of the arterial blood after smoking two cigarettes and only 1 per cent reduction after the fourth cigarette. The blood pressure had returned almost to its presmoking level after the third cigarette but the pulse rate remained elevated.

thrombo-angiitis obliterans, despite heavy smoking, was not accompanied by an elevated blood pressure.

Pulse Rate.—In patients with a normal or low initial pulse rate, smoking usually produced a tachycardia. The pulse rate, as a rule, increased with each cigarette until a level was reached which was not affected by further smoking. In thrombo-angiitis obliterans the pulse rate may be unaffected by smoking (Table V). As a rule the tachycardia disappeared with discontinuance of

smoking and as the normal rate was restored, smoking again produced an increase in the rate. The most marked response in pulse rate occurred among the moderate smokers whether normal controls or clinically recovered cases of thrombo-angiitis obliterans (Charts 3, 4, and 5).

Respiratory Rate.—The resting rate was not affected by smoking either in the normal controls or in patients with thrombo-angiitis obliterans. The average rate was 16 per minute.

Venous Blood.—In five of the six normal controls, and in all the improved

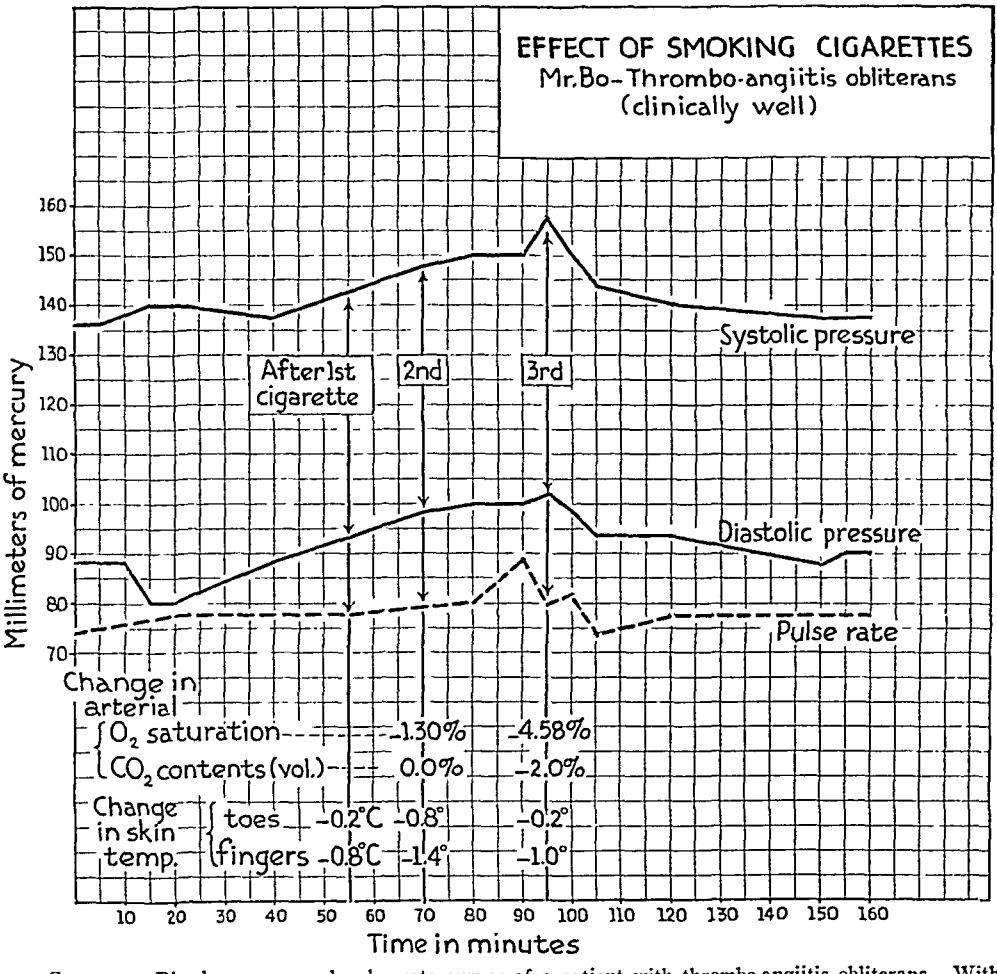


CHART 5.—Blood pressure and pulse rate curves of a patient with thrombo-angiitis obliterans. With the pulse rate unchanged after smoking there was a 1 per cent reduction in the oxygenation of the arterial blood after smoking two cigarettes and 4½ per cent reduction after the third cigarette.

and recovered cases of thrombo-angiitis obliterans the oxygen saturation of the venous blood[15] was higher after smoking (Table II). In one patient the venous blood contained 11 per cent more oxygen following the smoking of two cigarettes and 22 per cent more after four cigarettes. In two other cases there was a 22 per cent increase in oxygen saturation. We may assume that with excessive tobacco consumption the oxygen content of the venous blood may nearly reach the level present in the arterial blood.

TABLE II

CHANGES IN VENOUS BLOOD; OXYGEN AND CARBON DIOXIDE DETERMINATIONS, AND IN PERIPHERAL TEMPERATURES AFTER SMOKING

	Before Smoking O_2 Saturation	Number of Cigarettes Smoked	Change in O_2 Saturation Percentage	Change in CO_2 Content Vol. %	Average Change in Peripheral Temp. Toes	Average Change in Peripheral Temp. Fingers
Normal controls						
Mr. S.	61.20%	2	+ 8.70%	−2.79	−2.6° C.	
	87.40%	2	+ 4.10%	+1.58	−3.1° C.	
Mr. V.	56.00%	4	+ 4.93%	−2.33	−2.6° C.	−3.6° C.
Mr. M.	72.00%	4	+ 2.20%	+1.80	−2.2° C.	−1.4° C.
Mr. J.	30.86%	4	+14.60%	−0.36	0.0° C.	+0.3° C.
Mr. O.	83.16%	1	− 5.59%	0.00	+0.2° C.	+0.1° C.
Peripheral circulatory disease						
Thrombo-Angiitis Obliterans†:						
Active cases—smoking.						
Mr. P.	99.40%	4	−10.00%	+2.84	0.0° C.	0.0° C.
Mr. Nic.	77.23%	1	−12.52%	+3.33	−1.2° C.	−1.1° C.
		4	−20.97%	+1.16	−1.6° C.	−2.3° C.
Mr. Nie.	56.19%	2	− 3.91%	−2.11		
Improved or recovered cases.						
Mr. B.	62.71%	2	+11.18%	−3.34		
	31.00%	4	+22.60%	−7.12	+1.0° C.	−1.3° C.
Mr. M.*	61.36%	1	+ 0.79%	−3.15	+0.8° C.	−2.5° C.
Mr. S.	83.71%	4	+ 1.23%	−6.54	−0.8° C.	−1.7° C.
Mr. P.	64.65%	3	+ 6.85%	+0.16	0.0° C.	−0.6° C.
Nonthrombo-Angiitis Obliterans:						
Neurocirculatory.						
Miss K.	65.33%	4	+22.67%	−3.75	−0.9° C.	−0.9° C.
Senile arteriosclerotic.						
Mr. R.	59.37%	2	+ 1.13%	−0.15	−2.5° C.	−0.3° C.

* Became ill—nauseated, vomited and coughed.

† These patients were intensively treated with sodium tetrathionate which is prepared for us experimentally and supplied by G. D. Searle and Company of Chicago.

In three cases of acute thrombo-angiitis obliterans the opposite results were obtained. In one, there was 12 per cent reduction in oxygen saturation of the venous blood after smoking one cigarette and 21 per cent reduction after the fourth cigarette. The almost complete oxygen saturation, which we reported previously,[7] was present in the superficial venous blood obtained from the involved extremity and not from the right antecubital vein which was routinely used in this investigation. The average oxygen saturation before smoking was, however, higher than in the other series. These findings could be explained by slowing of the peripheral circulation or by interference with oxygenation of the arterial blood in the lungs, which reduces the oxygenation of the venous blood.[15]

Arterial Blood.—In four of five normal control patients the oxygen saturation of the arterial blood was less after smoking than before smoking. In the fifth case, increased saturation occurred but this change was accompanied by a marked elevation in blood pressure and increase in pulse rate (Chart 3). These latter changes may have been compensatory adjustments that caused the increased oxygenation.

TABLE III

CHANGE IN ARTERIAL BLOOD; OXYGEN AND CARBON DIOXIDE DETERMINATIONS, AND IN PERIPHERAL TEMPERATURES AFTER SMOKING

	Before Smoking O_2 Saturation	Number of Cigarettes Smoked	Change in O_2 Saturation Percentage	Change in CO_2 Content Vol. %	Average Change in Peripheral Temp. Toes	Average Change in Peripheral Temp. Fingers
Normal controls						
Dr. K. K....	91 89%	4	+ 4 51%	−4 30	−2.9° C.	−2.1° C.
Mr. O.	92 94%	1	− 0 86%	−1 19	+0.2° C.	+0.1° C.
Miss H.....	91.37%	3	− 1 61%	−0 15	−2.6° C.	−4.3° C.
Dr. B.*... ...	96 40%	1	− 2 10%	+0 21	.. .	
		3	− 1 30%	+0 14	−3.9° C.	−4.1° C.
Peripheral circulatory disease						
Thrombo-Angiitis Obliterans†:						
Mr. Nie.....	93.15%	2	− 5 15%	−0 16		
Mr. B....	93 07%	3	− 2 14%	−3 50	−0.3° C.	−0.6° C.
Mr. P. (Smoking heavy)	95.19%	3	− 0 33%	−4.21	0.0° C.	−0.6° C.
Mr. Bo.	101.30%	2	− 4 40%	−1.41		
	91 52%	2	− 1 30%	−0 02	−0.8° C.	−1.4° C.
		3	− 4 38%	−2 02	−0.2° C.	−1.0° C.
Mr. R.	91 45%	4	− 0 50%	−0 96	−2.9° C.	−0.9° C.
	91 91%	2	− 2 46%	+0 81	−1.3° C.	−1.3° C.
Mr. M.* (Not smoking)	80 95%	1	+11 17%	−0 45	+0 8° C.	−2.5° C.
Mr. B. (No smoking for 12 hrs., see Table V) ..	81 20%	2	+ 5 90%	−1 40	−0.7° C.	+0.2° C.
Nonthrombo-Angiitis Obliterans:						
Neurocirculatory.						
Mr. De M.* (Not smoking)	92 34%	2	+ 3 56%	−0 20	−0.9° C.	−1.0° C.
Senile arteriosclerotic.						
Mr. R.....	91 64%	2	+ 0 32%	+0 21	−2.5° C.	−0.3° C.

* Became ill—nauseated, vomited and coughed.

† These patients were intensively treated with sodium tetrathionate which is prepared for us experimentally and supplied by G. D. Searle and Company of Chicago.

Patients with thrombo-angiitis obliterans showed the most marked reduction in the oxygen saturation of the arterial blood. As noted in Table III, the oxygenation of the blood was further reduced after successive cigarettes. No change occurred in a recovered case of thrombo-angiitis obliterans who had a blood pressure of 170/86 and who continued to smoke two or more packages of cigarettes daily. Two patients with thrombo-angiitis obliterans had increased oxygenation after smoking but the initial determinations were exceptionally low (80 and 81 per cent). Low oxygen saturation of the arterial blood was present in a number of clinically recovered cases of thrombo-angiitis obliterans when smoking had been curtailed or discontinued.

COMMENT.—Heretofore, the effects of smoking have been considered as individual systemic responses without correlating the usual complex protective compensatory adjustments which the body is capable of making to changing conditions. The physiologic reactions to smoking can be attributed to the deficient oxygenation of the arterial blood.[16] With smoking, the diminished oxygen supply is transitory in most individuals and rapid compensatory changes occur. The amount of tobacco consumed as well as the frequency of deep inhalation are probably important factors in the ability of the body to

TABLE IV

EFFECT OF SMOKING UPON NORMAL CONTROL PATIENTS

	Before Smoking	After Smoking			
	Stabilized Condition	1st Cig.	2nd Cig.	3rd Cig.	4th Cig.
Dr. K. K.—Moderate smoker. Became slightly ill and dizzy during third cigarette.					
Arterial					
O_2 Saturation	91.89%			96.40%	
Change				+ 4.51%	
CO_2 Content (vol.)	51.65%			47.35%	
Change				− 4.20%	
Pulse rate	64	96	96	108	92
Blood pressure	104/76	124/76	124/76	136/82	120/78
Peripheral temp. (Av.)					
Toes	31.5° C.	29.2° C.	28.6° C.	28.8° C.	28.9° C.
Fingers	32.5° C.	30.2° C.	30.4° C.	31.5° C.	32.7° C.
Dr. B.—Moderately heavy smoker. Became ill after fourth cigarette.					
Arterial					
O_2 Saturation	96.40%		94.30%		95.10%
Change			− 2.10%		− 1.30%
CO_2 Content (vol.)	42.57%		42.78%		40.58%
Change			+ 0.21%		− 1.99%
Pulse rate	82	76	90	90	90
Blood pressure	120/76	126/82	132/84	130/86	122/80
Peripheral temp. (Av.)					
Toes	33.0° C.	29.8° C.	29.0° C.	28.8° C.	31.6° C.
Fingers	33.6° C.	30.5° C.	30.4° C.	31.6° C.	34.0° C.

make the adjustments. These factors naturally differ in each individual and with each type of smoking. Continual failure of systematic responses to compensate for the decreased oxygen tension in the tissues and internal organs may produce metabolic disturbances throughout the body.[17]

In acute cases of thrombo-angiitis obliterans as previously reported by us, acapnia may be present. As noted in Table III, the oxygen saturation of the arterial blood was reduced as much as 5.15 per cent after smoking only four cigarettes. Compensatory adjustments in blood pressure, pulse rate, respiratory rate, red blood counts, acclimates the individual to the reduced oxygen supply. Any one or more of these systemic adjustments may be inadequate but this is compensated for by greater changes in the others. Tachycardia, hypertension, polycythemia, or increased respirations may all contribute in supplying sufficient oxygen to the tissues.

In thrombo-angiitis obliterans a polycythemia was occasionally present in the improved or recovered stage of the disease. During the acute stage there was usually an anemia which was not amenable to recognized hematopoietic stimulants. Although the changes in erythrocyte counts which followed the smoking tests were inconstant, the pulse rate and the blood pressure were definitely affected by smoking. The efficiency of the compensatory mechanisms for anoxemia seems to be the determining factor in the development of the disease.

Females, whether smokers or nonsmokers, responded more actively to smoking than did males. In all cases thus far examined, there was an active

TABLE V

EFFECT OF SMOKING UPON PATIENTS WITH THROMBO-ANGIITIS OBLITERANS

	Before Smoking	After Smoking			
	Stabilized Condition	1st Cig.	2nd Cig.	3rd Cig.	4th Cig.
Mr. R —Clinically improved.					
Arterial					
O_2 Saturation	91 91%		89 45%	87 81%	
Change			− 2 46%	− 4 10%	
CO_2 Content (vol)	50 10%		50 91%	50 72%	
Change			+ 0 81%	+ 0 62%	
Pulse rate	80	80	80	80	
Blood pressure	110/60	110/60	120/60	124/60	
Peripheral temp (Av)					
Toes	29 6° C.	29 9° C.	28.8° C.	28.8° C.	
Fingers	33 5° C.	33.2° C.	32.3° C.	33 0° C.	
Sedimentation time	1 hour 45 minutes				
Mr. Bo —All four extremities involved. Clinically well.					
Arterial					
O_2 Saturation	91 52%		90 22%	86 94%	
Change			− 1.30%	− 4 58%	
CO_2 Content (vol)	42 43%		42 41%	40 41%	
Change			− 0 02%	− 2 02%	
Pulse rate	77	78	80	80	80
Blood pressure	138/88	142/92	148/98	158/102	136/94
Peripheral temp. (Av.)					
Toes	29 8° C.	29.9° C.	29 3° C.	29.9° C.	30.8° C.
Fingers	31.9° C.	31.2° C.	30 6° C.	31.0° C.	31.9° C.
Sedimentation time	1 hour 45 minutes				
Mr. Br.—Acute case. Smoking markedly curtailed—almost complete abstinence from previous two or three packages per day.					
Arterial					
O_2 Saturation	81 20%		87 10%		86 20%
Change			+ 5 90%		+ 5 00%
CO_2 Content (vol.)	47 10%		45 70%		46.40%
Change			− 1 40%		− 0 70%
Pulse rate	84	87	90	88	86
Blood pressure	128/86	134/86	144/90		138/86
Peripheral temp. (Av.)					
Toes	32 5° C.	32.2° C.	31.8° C.	31.6° C.	29.5° C.
Fingers	33.4° C.	33.6° C.	33.6° C.	34 0° C.	33.3° C.
Sedimentation time	25 minutes				25 minutes
Red blood counts (millions)	3 9		3.7		3.9
Change			− 0 2		
Reaction of the blood (*p*H)	7 48		7 52		7 52
Mr. P.—Heavy smoker. Right leg previously amputated. Clinically well.					
Arterial					
O_2 Saturation	95 19%			94.86%	
Change				−0 33%	
CO_2 Content (vol)	46 68%			42 47%	
Change				− 4 21%	
Venous					
O_2 Saturation	64.65%			71.50%	
Change				+ 6 85%	
CO_2 Content (vol.)	49 11%			49 27%	
Change				+ 0 16%	
Pulse rate	70	70	70	76	
Blood pressure	170/86	178/86	170/86	170/86	
Peripheral temp. (Av.)					
Toes	30.7° C.	31.1° C.	31.2° C.	31.5° C.	
Fingers	33.3° C.	33.0° C.	32.6° C.	32.8° C.	
Sedimentation time	2 hours 15 minutes				

response in the pulse rate, blood pressure and peripheral temperatures, contrasting in this respect to the occasional exceptions in men. This may bear a relation to the fact that thrombo-angiitis obliterans rarely occurs in females.

The deleterious effect of smoking may be due to reduction in oxygenation of the arterial blood. Physiologic responses may overcome the interference with the oxygen absorption in the lungs or the entire body may become adjusted to the reduced oxygen tension in the tissues. Transitory lowered oxygen tension in moderate smokers probably has no ill effects, but Cannon[18] and his coworkers[19] believe that deficient oxygen supply to the liver, adrenals and intestines definitely contribute to rapid coagulation of the blood. There is evidence that adrenal dysfunction may be an etiologic factor in thrombo-angiitis obliterans. The usual changes in blood pressure, pulse rate, peripheral circulation, and the blood sugar[20, 21, 22] which follow cigarette smoking could be due to increased epinephrine output. Further, sympathectomized extremities responded to smoking in a similar fashion to the response to adrenalin.[14] In the acute stage of thrombo-angiitis obliterans adrenal dysfunction may be responsible for the absence of these responses. The characteristic dark blood in the acute stage is also found to be present in adrenalectomized animals.[23]

SUMMARY AND CONCLUSIONS

Tobacco smoking was usually accompanied by a greater reduction in the oxygenation of the arterial blood in patients with thrombo-angiitis obliterans than in normal individuals. The extent of the reduction seemed to be influenced by physiologic adjustments in the blood pressure, pulse rate, and peripheral skin temperatures.

Occasionally, when a marked increase in blood pressure and pulse rate followed smoking, the oxygen saturation of the arterial blood was found to be increased. The increased oxygenation was greatest in recovered cases of thrombo-angiitis obliterans who, after a period of abstinence from smoking, had particularly low oxygen saturation.

Decreased utilization of oxygen by the superficial tissues is indicated by the increased oxygen saturation of the venous blood associated with a decline in peripheral temperatures.

Failure of physiologic adjustments to compensate for the lowered oxygen tension in the tissues and internal organs may be an etiologic factor in thrombo-angiitis obliterans. The increased viscosity and other changes in the blood in thrombo-angiitis obliterans which we recently reported may be evidence of disturbed tissue metabolism.

BIBLIOGRAPHY

[1] Johnson, H. J., and Short, J. J.: Effect of Smoking on the Skin Temperatures. Jour. Lab. and Clin. Med., 19, 962–966, June, 1934.

Barker, N. W.: Vasoconstrictor Effects of Tobacco Smoking. Proc. of Staff Meet., Mayo Clin., 8, 284–287, May 10, 1933.

Wright, I. S., and Moffat, Dean: The Effects of Tobacco on the Peripheral Vascular System. J.A.M.A., 103, 318–323, August 4, 1934.

Sampson, R. S.: A Quantitative Study of the Vasoconstriction Induced by Smoking. J.A.M.A., 104, 1963–1966, June 1, 1935.

Graybiel, A., Starr, R. S., and White, P. D.: Electrocardiographic Changes Following Inhalation of Smoke. Am. Heart Jour., 15, 89–99, January, 1938.

Thienes, C. J., and Butt, E. M.: Chronic Circulatory Effects of Tobacco and Nicotine. Am. Jour. Med. Sci., 195, 522–529, April, 1938.

[2] Maddock, M. G., and Coller, F. A.: Peripheral Vasoconstriction by Tobacco and Its Relation to Thrombo-Angiitis Obliterans. ANNALS OF SURGERY, 89, 70-81, July, 1933.

[3] Maddock, M. G., Malcolm, R. L., and Coller, F. A.: Thrombo-Angiitis Obliterans and Tobacco: The Influence of Sex, Race, and Skin Sensitivity on Cardiovascular Responses to Smoking. Am. Heart Jour., 12, 46–52, July, 1936.

Herrell, W. E., and Cusick, P. L.: Vascular and Retinal Abnormalities Following Inhalation of Smoke. Proc. of Staff Meet., Mayo Clin., 13, 273–279, May 4, 1938.

[4] Wood, Willard L.: Unpublished data.

[5] Sulzberger, M. D.: Recent Immunologic Studies in Hypersensitivity to Tobacco. J.A.M.A., 102, 11–16, October, 1934.

[6] Harkavy, J., Habold, S., and Silbert, S.: Tobacco Sensitiveness in Thrombo-Angiitis Obliterans. Proc. Soc. Exper. Biol., and Med., 30, 104–107, October, 1932.

[7] Theis, F. V., and Freeland, M. R.: The Blood in Thrombo-Angiitis Obliterans. Arch. Surg., 38, 191–205, February, 1939.

[8] Maddock, M. G., Malcolm, R. L., and Coller, F. A.: Footnote 3.

[9] Barker, N. W.: Footnote 1.

[10] Wright, I. S.: Footnote 1.

[11] Herrell, W. E.: Idiosyncrasy to Tobacco. Proc. of Staff Meet., Mayo Clin., 13, 1–6, January 5, 1938.

[12] Johnson, H. J., and Short, J. J.: Footnote 1.
Sampson, R. S.: Footnote 1.
Graybiel, A., Starr, R. S., and White, P. S.: Footnote 1.

[13] Scott, W. J. M., and Morton, J. J.: The Differentiation of Peripheral Arterial Spasm and Occlusion in Ambulatory Patients. J.A.M.A., 97, 1212–1215, October 24, 1931.

[14] Smithwick, Reginald H., Freeman, Norman E., and White, James C.: Effect of Epinephrine on the Sympathectomized Human Extremity; An Additional Cause of Failure of Operation for Raynaud's Disease. Arch. Surg., 29, 759–768, November, 1934.

[14a] Freeman, N. C., Smithwick, R. H., and White, J. C.: Adrenal Secretion in Man: The Reaction of the Blood Vessels of the Human Extremity Sensitized by Sympathectomy, to Adrenalin and to Adrenal Secretion Resulting from Insulin Hypoglycemia. Am. Jour. Physiol., 107, 529–535, March 1, 1934.

[15] Peters, J. P., and Van Slyke, D. D.: Quantitative Clinical Chemistry: Interpretations. Baltimore, Williams and Wilkins Co., 1932, Vol. I.

[16] Barcroft, Joseph: The Respiratory Function of the Blood, Part 1. Lessons from High Altitudes. Cambridge University Press, 1925.

[17] Silbert, S., and Friedlander, M.: Studies in Thrombo-Angiitis Obliterans: The Basal Metabolism. J.A.M.A., 96, 1857–1858, May 30, 1931.

[18] Cannon, W. B., and Mendenhall, W. L.: Factors Affecting the Coagulation Time of Blood; IV. The Hastening of Coagulation in Pain and Emotional Excitement. Am. Jour. Physiol., 34, 251–261, March, 1914.

Idem: Factors Affecting the Coagulation Time of Blood; III. The Hastening of Coagulation by Stimulation of the Splanchnic Nerves. Am. Jour. Physiol., 34, 243–255, March, 1914.

[18a] Cannon, W. B., and Gray, Horace: Factors Affecting the Coagulation Time of Blood; II. The Hastening and Retarding of Coagulation by Adrenalin Injections. Am. Jour. Physiol., 34, 232–242, March, 1914.

[18b] Cannon, W. B., and Cattell, M.: Studies in Experimental Traumatic Shock; V. Critical Level in a Falling Blood Pressure. Arch. Surg., 4, 300–323, 1922.

[18c] Cannon, W. B.: The Emergency Function of the Adrenal Medulla in Pain and the Major Emotions. Am. Jour. Physiol., 33, 356–372, February 2, 1914.

[19] Gray, H., and Lunt, L. K.: Factors Affecting the Coagulation Time of Blood. Am. Jour. Physiol., 34, 332–351, June 1, 1914.

[20] Dill, D. B., Edwards, H. T., and Forbes, W. H.: Tobacco Smoking in Relation to Blood Sugar, Blood Lactic Aicd and Metabolism. Am. Jour. Physiol., 109, 118–122, July, 1934.

[21] McCormick, W. J.: The Rôle of the Glycemic Response to Nicotine. Am. Jour. Hygiene, 22, 214–220, July, 1935.

[22] Haggard, H. W., and Greenberg, L. A.: The Effects of Cigarette Smoking Upon the Blood Sugar. Science, 79, 165–166, February 16, 1934.

[23] Lucas, G. J. W.: Blood and Urine Findings in Desuprarenalized Dogs. Am. Jour. Physiol., 77, 114–125, 1926.

THE RATE OF HEALING OF TENDONS*

AN EXPERIMENTAL STUDY OF TENSILE STRENGTH

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THE PROBLEM of tendon healing and the various factors which affect it are still quite unsettled. Despite a great number of experimental and histologic studies which have appeared during the past 30 or more years, there is still lack of agreement concerning even the tissues which take part in the process. It is not necessary here to review the entire problem, which has been gone into in detail elsewhere (Mason and Shearon). The articles by Schwarz, F. Hesse, Biesin, Salomon, Närvi, Garlock, DeBarnardis, and others present extensive and exhaustive reviews to which the reader is referred. It may not be out of place, however, to outline very briefly the present status of the problem of tendon repair sufficiently to provide a background for the problem which we are now reporting.

Three tissues may take part in tendon repair—the tendon itself, the connective tissue in and on the surface of the tendon, and the connective tissue surrounding it. Various other cellular elements enter into the process, but the three mentioned are the important ones. Great difference of opinion exists, however, as to the part played by these various tissues in repair. The earlier workers thought that the tendon cells were the most important element in repair and that the connective tissues played a minor rôle. Recent workers, however, generally agree that the connective tissue elements are of great significance and many even deny that the tendon itself takes any part. In fact, many believe that tendon healing is simply scar tissue formation, similar to that occurring elsewhere, except for the fact that the physiologic requirements of this scar cause it to become equivalent to tendon. Others feel that while the connective tissues take part, they do not form ordinary scar but a specific tissue, in a manner similar to the periosteum. A few, like ourselves, have concluded that both the connective tissues in and about the tendon and the tendon itself take part in the process and that both are important.

From the standpoint of tissue participation, tendon healing may be divided into two stages. The first stage is the connective tissue stage, in which the connective tissues in, on, and about the tendon proliferate to form a fibroblastic cuff and scar about and between the tendon ends. This stage of repair comprises the exudative phase and the phase of fibroplasia and

* Read before the American Surgical Association, St. Louis. Mo., May 1, 2, 3, 1940.

terminates on the fourteenth to sixteenth day. The second stage of repair is dominated by processes going on in the so-called tendon callus which result in the conversion of this tissue into tendon. This is the formative stage or the stage of organizing differentiation. It is in this stage of regeneration or healing that we should look for evidences of specificity of tissue. It is our feeling that specific regenerative processes in the tendon dominate this stage. While histologic evidence of tendon cell proliferation may be found as early as the fourth or fifth day, their organization of the union becomes dominant on about the fourteenth day. If our concept of the process is correct, the new tissue uniting the stumps is true tendon, in the same way that bone callus becomes true bone. If this tissue is simply scar, some explanation must be given for its developing, histologically, into tissue almost indistinguishable from normal tendon.

Whatever the tissue is which eventually forms to unite the stumps, whether it be simply a scar or true tendon, there seems to be general agreement that it behaves as tendon and possesses the strength of tendon.

Out of a great amount of experimental data and philosophic discussion, there emerges, particularly, the question as to the significance of function on the process of tendon repair. The importance of function was emphasized by W. Roux, who stressed its value in maintaining tissue and in stimulating growth in normal tissue. Roux's ideas were introduced into clinical surgery by Wolff, who established the trophic principle of function as the factor which determines the character of supporting structures. Although he had in mind particularly the effect of function on the final form and structure of callus and bone, there is no doubt but that his conception of functional influence encompassed the whole of scientific medicine and general biology.

Many experimental studies have been carried out in an effort to determine the rôle function plays in the formation of tendon. E. Rehn demonstrated that under the influence of function connective tissue strips were converted into tendon-like structures. Similar results were obtained by Schwarz and Hueck. Hesse demonstrated that tendons transplanted into the knee joints of rabbits and dogs maintained their tendinous structure and if divided healed like tendon provided they were subjected to tension; whereas, if they were not subjected to tension, they soon regressed into ordinary fibrous tissue. Bier and Salomon insisted that tendon regeneration was specific and could proceed without function. They conceded, however, that while function was harmful during the first phase of healing, during the second phase or stage of differentiation it exerted a generally increasing influence in the sense of further differentiation, maintenance, and increase in the already laid down tissues. O. Levy concluded that function came into play only when organs begin to function. Hauck reached somewhat similar conclusions. Biesin concluded that fibrous tissue or the scar uniting tendon ends became tendon or at least differentiated into tissue equivalent to tendon under the influence of tension and use. Kleinschmidt showed that fascia lata

of the rabbit when grafted into a defect of the quadriceps muscle maintained those fascial layers which paralleled the line of pull of the muscle. Eventually, the whole fascial graft was replaced by connective tissue, but the effect of function on it was clearly demonstrated.

Studies on the effect of function on tendon healing and regeneration have dealt largely with observations on the gross and microscopic anatomy of the replacement tissues. It is common observation that after healing the newly formed tissue looks like tendon but never actually reaches a stage where it cannot be distinguished from it. Histologically, it is claimed that it can be distinguished from normal tendon even as long as one year after repair. No one, however, so far as we have been able to find, has made any detailed observations on the tensile strength of the new tendon or of the tendon union to determine just how closely it approaches that of normal tendon. Garlock, in 1927, as the result of an extensive series of experiments, concluded that after the fourth day "the scar tissue of itself becomes the bulwark in the maintenance of the continuity of the tendon. With stress and strain applied on the fifth day, in the form of passive motion (in experimental animals only) it appears from the sections that the scar joining the tendon ends stretched somewhat but not to any marked degree. . . . Following the fifth day the scar tissue between the divided ends of the tendon progressively increases in strength and density up to the day when the union is as firm as it will ever be." Mason and Shearon, in 1932, made a few observations on the gross amount of pull required to fracture the healing tendon or graft. They found that in the early stages the surrounding tissues were important but that later the tissues in the gap gained great strength. From the fourth to eighth day rupture occurred with pulls of 2½ to 4½ pounds, while after the second week pulls of 16 to 40 pounds were required. No attempts were made, however, to correlate these pulls with cross-sectional areas of the tendons nor, except in a general way, with the phases of repair.

The method for studying the rate of wound healing by determining tensile strength during various phases of healing was introduced by Harvey and by Howes, Sooy and Harvey, in 1929. They showed that the tensile strength of healing wounds in the skin, fascia, muscle, and stomach followed a curve similar to that determined by Carrel, Spain and Loeb, Carrel and Hartmann, duNoüy, Clark, Lumière, and others. They found that there was first a quiescent period or lag during which tensile strength was due entirely to the sutures. This lag period lasted four to six days and was followed by a proliferative phase characterized by a rapid increase in tensile strength, which produced a curve of progressively decreasing velocity to reach a maximum at about the fourteenth day, at which time many tissues will have regained normal strength. They also noted, however, that a third phase, "the phase of maturation," occurred, during which time structures such as bone and tendon regained their normal strength. This method of determining the rate of healing has now come into general use.

Personal observations made during earlier experiments with tendons indicated that the tensile strength was constantly increasing beyond that shown at the end of two or three weeks, and it was suspected that there would be two phases in the curve of increase in tensile strength. Experimental work reported by Howes, Harvey and Hewitt, in May of 1939, has shown that in cutaneous wounds of dogs, cats, rabbits, guinea-pigs, and rats the curve of healing as determined by tensile strength showed two rises. The first rise due to fibroplasia began about the fifth day and reached a maximum on the twelfth to fourteenth day. The second rise began on the eighteenth to twenty-second day, except for the guinea-pig in which it began on the thirtieth day. This rise indicated the stage of organizing differentiation, by which the tissue regained its normal strength. It was associated with histologic changes whereby the "entire architecture is differentiated without a vestige of embryonal pattern." The collagenous fibers become larger, blood vessels fewer and a tissue closely resembling but not quite identical with the normal results. This second phase of organizing differentiation lasts until normal strength is regained—in the rat in 60 days, in the rabbit in 180, while in the dog the scar does not regain the normal strength of the skin even after 358 days.

The second phase of increase in tensile strength would seem to correspond in its onset with the time when the tenoblastic phase in tendon healing becomes the most important. We should expect to find, therefore, a curve in tendon repair similar to that found by Howes, Harvey and Hewitt in the skin. It is this phase of repair, that of organizing differentiation or maturation, which histologic studies show to be especially influenced by function; and if function does accelerate differentiation, we should be able to detect it by a study of the tensile strength of healing tendons.*

* The tensile strength of any particular tendon is difficult if not impossible to determine; and after a study of the reports in the literature and personal experimentation, we are inclined to agree with Cronkite that a norm cannot be established. Gratz has made a number of important contributions on the subject of the strength of fibrous tissues and has made an exhaustive study of tendon strength in man and various domestic animals. He found that certain fibrous tissues "withstood stress up to a maximum of 1,476 Kg. per sq. cm. (20,959 pounds per sq. in)." Many tissues exceeded this figure. Nicola reported on the strength of four human tendons with an average tensile strength of 7,330 pounds per sq. in. (645 Kg. per sq. cm.). Cronkite measured the tensile strength of 294 human tendons, some fresh, but for the most part dissecting room material. He found considerable variability not only in different cadavers, but in specimens from the same cadaver. Thus, the range for the whole series was from 4,000 to 30,000 pounds per sq. in. while the averages ranged from 8,700 to 18,000 pounds per sq. in. (611 to 1,265 Kg. per sq. cm.). We made attempts to obtain the tensile strength in a number of normal dog tendons utilizing, as a rule, several segments from each tendon. Our results indicated a tensile strength which varied from 3,250 to 18,170 Gm. per sq. Mm. and averaged 9,386 Gm. per sq. Mm. in 15 fresh tendons. We have also tested human tendons taken from a dissecting room cadaver. Cronkite has shown that the tensile strength in these tendons is approximately the same as in fresh tissue. Our figures ranged from 6,540 Gm. per sq. Mm. (9,281 pounds per sq. in.) to 25,490 Gm. per sq. Mm. (36,140 pounds per sq. in.).

In this series of experiments an attempt has been made to ascertain the rate at which the healing sutured tendon regains its tensile strength. The work has been carried out upon the dog, using, in 16 experiments, the extensor carpi radialis tendon, and, in 94 experiments, the flexor carpi ulnaris. In each case the tendon was exposed under aseptic precautions with the dog under intravenous nembutal anesthesia. The tendon sheath was split open for a distance of about 5 cm., the tendon separated from its mesotenon and divided transversely with a sharp knife. The ends were immediately united

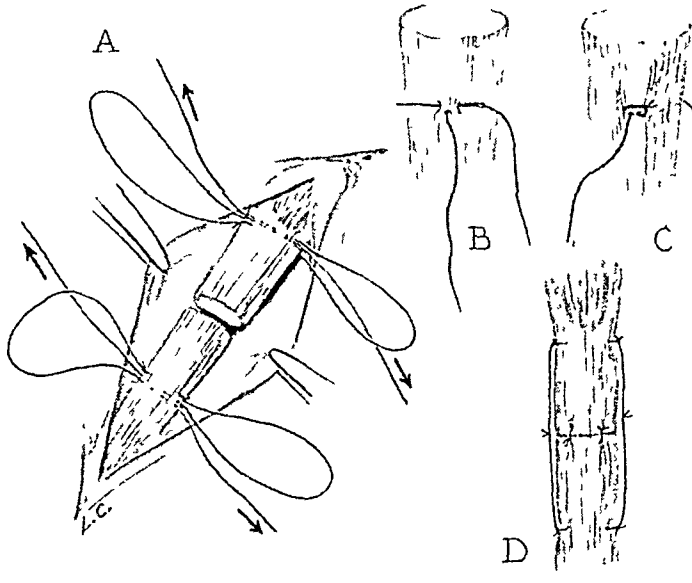


FIG. 1.—Showing the method of tendon repair, whereby the tension sutures pull transversely to the tendon fibers. A small bundle of fibers is caught at the side of the tendon about 1 cm. from the divided end. The suture is then passed straight through the tendon to emerge on the opposite side. A second suture is then taken and a small bundle of fibers is caught just below the point of emergence of the first suture, between it and the end of the tendon. The second suture is then passed straight through the tendon and emerges above the knot of the opposite suture and between the fiber bundles which have been caught in it. When each suture is drawn toward the cut end of the tendon, it rides over the knot of the opposite suture, as if over a pulley, and the longitudinal pull is converted into a transverse one. Accurate approximation of the tendon ends is obtained by a few fine silk sutures which unite the peritendinous tissues at the site of apposition.

with No. 8, Champion, twisted, untreated silk. The type of suture in all but six instances was that recently described by one of us. It consists of a pair of transverse sutures introduced into the tendon about 1 cm. above the cut end in such a way that one emerges from the side of the tendon above the knot of the opposite suture and is held there by the tendon fibers which have been grasped in the knot (Fig. 1). In this manner, the line of pull of the suture is transferred from a longitudinal to a transverse direction. This suture will rupture at the knots with 5.23 pounds without pulling out of the tendon. Despite the fact that the suture breaks, we believe that finer sutures are indicated. This method of suture possesses the advantage of leaving free the tendon ends which we wish to take part in the healing process. There

is no disadvantage to the length of suture lying on the outside of the tendon. The sutures are soon covered by a thin sheet of tissue and when healing is complete lie embedded apparently under no tension on the surface of the tendon without causing any interference with gliding action.

Following suture the sheath is not closed, but the subcutaneous fatty tissues are approximated over the suture site, and the skin is closed with silk. A pressure dressing is applied, and a plaster bandage applied to the leg to hold the sutured tendon in relaxation.

The wounds were reopened under aseptic precautions at intervals varying from two to 68 days, and the sutured tendon was examined and removed. The gross amount of reaction was noted, the amount of separation between the stumps measured, the width of the stumps was taken, and measurements made of the distance of the sutures from the tendon ends. The stumps were then fastened as securely as possible in hemostats and attached to a spring scale where tension was slowly applied until separation started, which point was taken as the measurement of tensile strength. In some specimens it was not possible to rupture the complete tendon by our apparatus. In many of these instances the tendon was divided longitudinally and a small segment was subjected to the experimental pull.

The sutures were not divided before testing the strength although in a few instances one or both had broken or untied before the tendon was removed. The measurements and observations given, therefore, record the strength of the tendon plus that added by the suture. It was believed that in this way a truer idea of the clinical situation could be gained. We were also able to make some observations on the holding power of the tendon for the suture, a factor we believe to be of clinical importance.

In a number of the earlier experiments we simply recorded the number of pounds or ounces needed to break the tendon. This holds true especially for the two- and seven-day specimens in which we have only the measurements of the diameter of the stumps. We soon realized, however, that this measurement was not sufficient if we wished to compute tensile strength. In later experiments, therefore, two measurements were made, one, the greater, and one, the lesser diameter of the tendon or segments; and from these the cross-sectional area of the tendon was computed as an ellipse and tensile strength computed in terms of grams per sq. Mm. In those specimens in which but one diameter was measured, the cross-sectional area was determined by assuming that the lesser diameter was slightly more than one-half of the greater. Figures on tensile strength so arrived at are recorded as *estimated*; whereas, those in which actual measurements of both diameters were made are recorded as *computed*. While we cannot claim absolute accuracy of the cross-sectional area, we believe that the error is distributed equally throughout the series and that the figures are sufficiently accurate for comparative purposes.

For purposes of study the flexor tendons were divided into a number of

groups depending upon the period of immobilization of the leg in the plaster encasement, the length of time the leg was used, and the manner in which it was used. In one group (Group B_1) observations were made on tendons taken from a leg held rigidly in a plaster encasement for periods varying from two to 35 days. In another group (Group B_2) of animals we removed the encasement after three weeks' immobilization, and the animal was allowed free use of the extremity for from one to six weeks. In a certain number of instances (Group B_3) the animal loosened or completely removed the plaster encasement. In this group, record was made of the time that this took place and the tensile strength of the sutured tendon was measured at varying intervals afterwards. In another series (Group B_4) a plaster encasement and metal splint was applied (Fig. 7) in such a manner that at the end of one week of rigid immobilization the paw was released and the animal permitted to flex but not to extend its foot beyond the point of original immobilization.

It would serve no useful purpose to report each experiment separately. Each observation is, however, recorded in the tables, and each group is separately plotted in Chart I by a curve representing the averages of tensile strength in grams per sq. Mm.

RÉSUMÉ OF PROTOCOLS OF EXPERIMENTS

Group B_1 (Table I)

Two Days.—In one of the six specimens removed on the second day (33R) the suture line held to 4 pounds at which time one of the strands of the suture broke; the other strand held to 2½ pounds and then broke. In all others the ends first separated and then the sutures pulled through the stumps. In one instance (35L) the tendon had almost the same holding power for the silk which it possessed immediately after suture, that is, 5 pounds. When pull was applied, separation started at 2 pounds, then the suture slowly pulled out of the proximal stump and separation was complete at 5¼ pounds. In the others (33L, 34L, 34R and 35R) when the pull was applied, an initial separation occurred at ¼, 2, 2, and 1 pound, respectively, and final separation took place at ¾, 3¼, 2¼ and 1¾ pounds. The tissues about the site of union at this time were soft and gelatinous. A minimal separation was observed between the tendon ends, varying from none at all to 5 Mm. in one specimen. The tensile strength in grams per sq. Mm. has been estimated for the two-day specimens at 58.19 Gm.

Three Days.—In one tendon (66L) separation began at ½ pound, in the other (67R) at ¼ pound; while final separation occurred at 4 and at ¾ pound, respectively; in each instance the suture pulled through. The tensile strength was computed at 3.55 Gm. per sq. Mm. By the third day the stumps were slightly thickened and soft, and the surrounding tissues had formed a small soft gelatinous cuff.

Five Days.—The separation started at ¾ pound in two specimens (62L and 63L), at 1½ pounds in a third (70L), and at ¼ pound in the fourth (71L). In all but one specimen (70L) the sutures pulled out of one of the stumps at ½, ¾ pound, and 1½ pounds, respectively (62L, 63L, 71L). In one specimen (70L) in which the initial separation occurred at 1½ pounds, one of the sutures broke at this pull while the other suture pulled out at 4¼ pounds carrying with it a tag of softened tendon. The computed tensile strength was 14 Gm. per sq. Mm. The stumps were possibly somewhat more edematous than on the third day; they were still gelatinous, and the intervening tissues were purplish in color.

Seven Days.—The tendon ends were becoming more definitely fused together by the cuff of soft tissue first noted on the third day. This cuff had become grayer, firmer and more fibrous in appearance. The average tensile strength (estimated) was 44 Gm. Initial separation in the seven-day specimens occurred at 1, 5/8, 3/8, 1 1/16 and 3¼ pounds, respectively. In four of the specimens the sutures pulled out of one of the stumps at 2⅛, 1⅛, ½ and 6½ pounds, while in one specimen (40L) the suture broke at 5 pounds after the initial separation at 2¼ pounds. We note for the first time a gelatinous layer of tissues surrounding the line of union pulling away as a definite cuff attached to one of the stumps when separation occurs.

Nine Days.—The six nine-day specimens (44L, 56R, 57R, 98L, 100L, 109R) started to separate at 1⅝, ¾, ½, 13/16, 13/16 and 4½ pounds, respectively; in two instances (44L and 56R) final separation occurred by the suture breaking at 2½ and 5⅜ pounds, respectively, while in all the

others the suture pulled out of one of the stumps (Fig. 2 A, B, C and D). The average tensile strength of the six specimens was 56.28 Gm. per sq. Mm. The reaction in the surrounding tissues showed no differences from those noted two days earlier except that specimens 98L, 100L and 109R were somewhat bulbous and there was moderate to marked thickening of the sheath (Fig. 3 A).

Ten Days.—The initial separation occurred at 3¾, 5½ and 5¾ pounds, while final separation in the first two specimens occurred when the sutures pulled out at 2¾ and 5½ pounds. In one specimen (87L) there was sudden separation with pull out of suture at 5¾ pounds. The tendon ends at ten days were quite intimately fused by a thick cuff of gray tissue which is part and parcel of the union (compare Fig. 2 A, B, C and D, and Fig. 3 A). Though this sheath is an important element in the tensile strength at this time, its own tensile strength is not directly proportional to its size. We may contrast here the two specimens, 86L and 87L, which broke at 5½ and 5¾ pounds, respectively. The tendons in these two specimens at the time of suture each measured 8 Mm. across. When they were uncovered at the end of ten days, the site of union, that is tendon plus the surrounding tissues, measured 34.6 sq. Mm. in 86L, and 21.2 sq. Mm. in 87L. Although 86L was over 60 per cent larger, its tensile strength in grams per sq. Mm. was 61.7; whereas 87L had a tensile strength of 115.4.

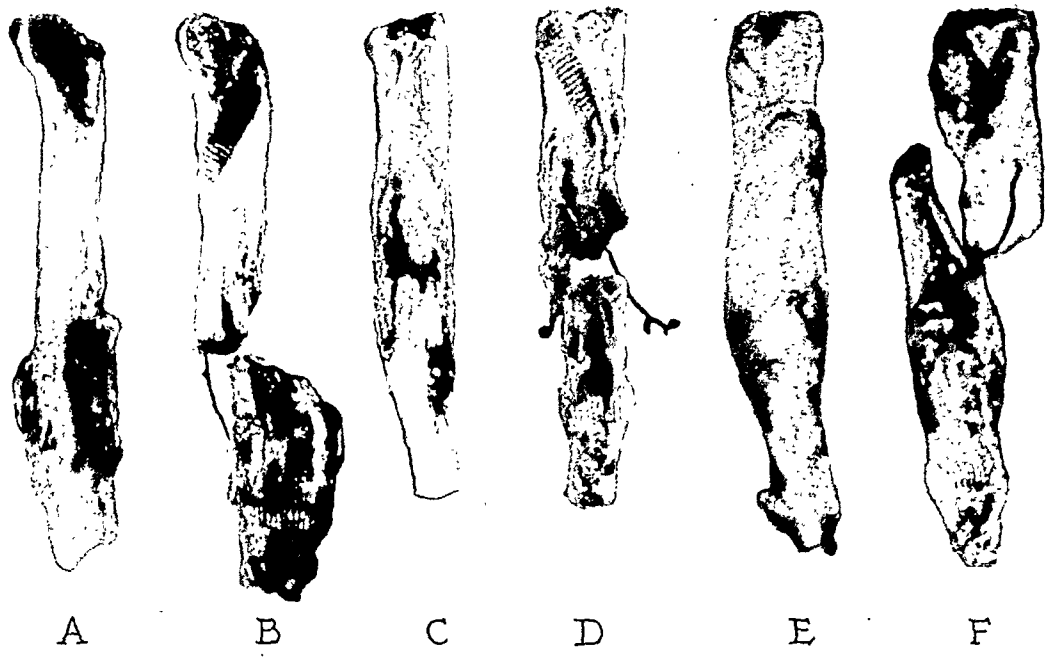


FIG. 2.—Photographs showing the manner of tendon rupture:
A and B (98L, group B_1; complete immobilization, nine days). A. Before rupture, shows bulbous thickening at site of union which is covered by a glove of thickened adherent sheath tissues with no separation. B. Rupture occurred with a pull of 6,320 Gm.; the glove remained adherent to the distal stump and the sutures pulled out of the proximal stump. Tensile strength 78.1 Gm. per sq. Mm.
C and D (109R, group B_1; complete immobilization, nine days. C. Before rupture, shows a very slight thickening. The sutures are visible through the sheath tissues. Tendon ends are visible, and there is no separation. D. Rupture occurred in a manner similar to B. Gross pull 2,042 Gm.; tensile strength 39.55 Gm.
E and F (95L, group B_1; plaster encasement, seven days, restricted use, 12 days). E. Before rupture, shows bulbous thickening. Sutures visible in gross specimen but do not show up in photograph. No separation. F. Rupture across line of union with breaking of sutures. Glove of sheath tissues remained attached to distal stump. Gross pull 5,883 Gm.; tensile strength 84.75 Gm.

Twelve Days.—The average tensile strength was 91.92 Gm. per sq. Mm. as compared with 88.55 for ten days, and ranged in the three specimens from 63.08 to 123.1. The ends of the tendons were found to be fused, and the reaction about them minimal or moderate. There was virtually no separation; in two, a questionable 1 Mm. separation had occurred; in the third, there was none. In two instances the sutures pulled out at 2½ and 3¼ pounds; in the third instance, the sutures broke at the knot at 4⅜ pounds.

Fourteen Days.—Seven specimens were removed at this stage, with the average tensile strength of 135.1 Gm. per sq. Mm. The cuff of peritendinous tissue in practically all specimens remained attached to one stump when rupture occurred through the intervening tissues; however, the sutures may either pull through or break at gross pulls of 2½ to 15¼ pounds.

Fifteen Days.—One single specimen (85R) in a very large dog broke at 4½ pounds and separated in about the same manner that one would anticipate in a nine- to ten-day specimen, with a tensile strength of but 52.9 Gm. per sq. Mm. The sheath tissues in this specimen were beginning to loosen and were slightly movable over the tendon beneath.

Sixteen Days.—Three specimens (63R, 82R, 83R) have an average tensile strength of 174.7 Gm. per sq. Mm. The cuff of surrounding tissues would appear to be adding less to the strength of union since gliding is beginning to appear. In the specimen in which this was noted (82R) the tendon fractured at the suture line at 11 pounds; then the sheath and sutures held to 6 pounds when both gave way, leaving a cuff of tissues attached to the distal stump. Separation in these three specimens was minimal—3 Mm. in 63R, and none in the other two.

Nineteen Days.—At 19 days (56L, 57L, 89R), the average tensile strength was 148.9 Gm. per sq.

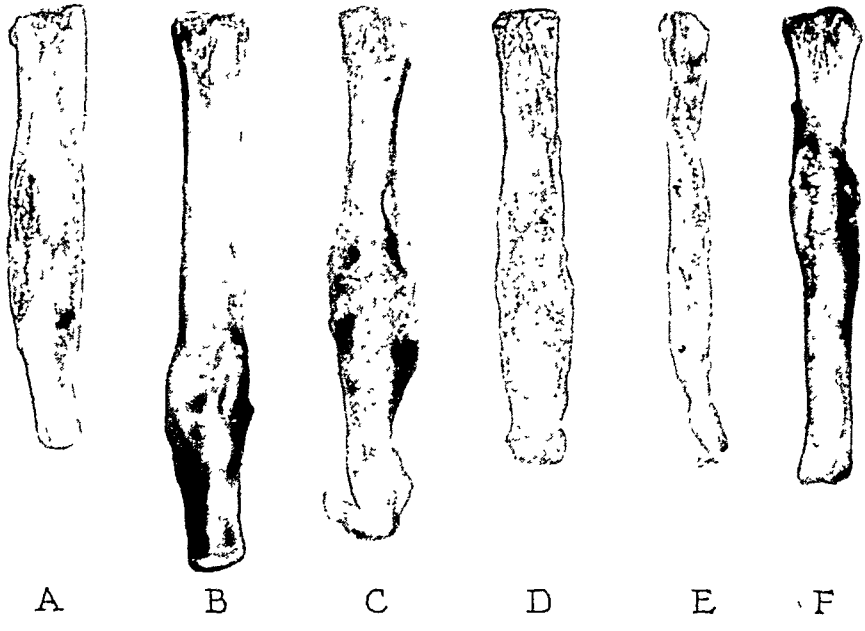


FIG. 3.—Photographs showing the types of union obtained in different flexor groups:
A (109R, group B_1; complete immobilization, nine days). Moderate reaction, moderate uniform swelling, sutures visible through sheath tissues. No separation. Tensile strength 39.55 Gm.
B (101R, group B_2; complete immobilization, three weeks, active use, two weeks). Moderate bulbous thickening. Sutures visible. Tendon glides in sheath. Ten millimeters separation. Tensile strength 377.6 Gm.
C (96L, group B_3; complete immobilization, seven days, unrestricted use, 12 days). Marked reaction and hemorrhage. Stumps bulbous. Three millimeters separation. Tensile strength 221.3 Gm.
D and E (108R, group B_3; complete immobilization, seven days, unrestricted use, nine days). Palpable bulb under skin. Each bulbous stump palpable. Sheath thick and adherent. E shows a longitudinal segment; stumps and sheath fused into continuous mass. Seven millimeters separation. Tensile strength 204 Gm.
F (106R, group B_4; complete immobilization, seven days, restricted use, 12 days). Figure 8 is drawing of this specimen. Minimal reaction in surrounding tissues. Tendon glides well through sheath. Sutures visible. Very slight enlargement of stumps. No separation. Tensile strength 176.99 Gm.

Mm. In one instance (56L) the separation had been 5 Mm., and the tensile strength was but 102.5 Gm. There was no separation of the stumps in the other two tendons in this group. The reaction about the site of union was not marked in any of them. The sheath tissues were gray, and the sutures could be visualized through them.

Twenty-one Days.—At 21 days (48L, 50L, 104R and 105R), the average tensile strength was 169.6 Gm. per sq. Mm. All specimens showed a minimum of reaction, and it would appear that healing was taking place under favorable conditions. All structures fractured suddenly with the application of a fair amount of gross pull, 11¾, 12, 13⅛ and 13½ pounds, respectively. The sutures and the suture line fractured simultaneously. The surrounding tissues had formed a gliding sheath and were no longer a fibrous cuff. The sutures were visible, and the ends of the tendons were not bulbous.

Twenty-eight Days.—At 28 days (95R, 96R and 100R), the tensile strength averaged 199.1 Gm. per sq. Mm. Healing has taken place very beautifully and except for a slight transverse grayish-pink or gray discoloration the line of apposition of the stumps could not be detected. There was a questionable separation of 1 Mm. in one specimen (100R), none in the other two. The sheath had completely reformed and, while slightly thicker than the normal sheath, could be lifted from the surface of the tendon to which it was attached by a few fine adhesions which allowed it to glide for 1 or 2 Mm. over the surface. The sheath was slightly grayer and less transparent than the normal sheath; however, one could see the sutures and the striated tendon beneath it. The tendon stumps, which have been enlarged in earlier specimens, were now about the same size as they had been when the suture was carried out. The manner in which 95R and 96R ruptured is of interest: In each case the rupture occurred halfway across the suture line and then, as the pull was kept up, the tendon broke across the other half at the place in the distal stump through which the tension suture had passed.

Thirty Days.—At 30 days (46R), a specimen similar in appearance to that seen at 28 days was found. The tendon ends were visible, the sutures visible, the sheath glided over the line of union, and there was no separation of the stumps. The tendon was quite small, slightly if any larger than when operation was performed. Fracture occurred across the line of apposition associated with pulling out of the tension suture on one side and breaking on the other side, at a pull of 7½ pounds with a computed tensile strength of 267.3 Gm. per sq. Mm.

Thirty-five Days.—At 35 days (42R, 44R, 92L, 90L and 93L), the tendons had the same gross appearance that was exhibited by the 28- and 30-day specimens. The union in all looked perfect (Fig. 4); in one, a possible separation of 1 Mm. was measured; in the other four there was no apparent separation. The sheath was thin and transparent so that the sutures, including the fine appositional ones, were visible. The tendon glided through the sheath tissues without obstruction. The tendon itself was not bulbous; in fact, in two instances (42R and 44R) the diameter was slightly less than it had been at operation five weeks previously. All five ruptured through the suture line at gross pulls of 1½ to 12¾ pounds. The tensile strength varied from 61.9 to 291.5 Gm. per sq. Mm, with an average of 177.4.

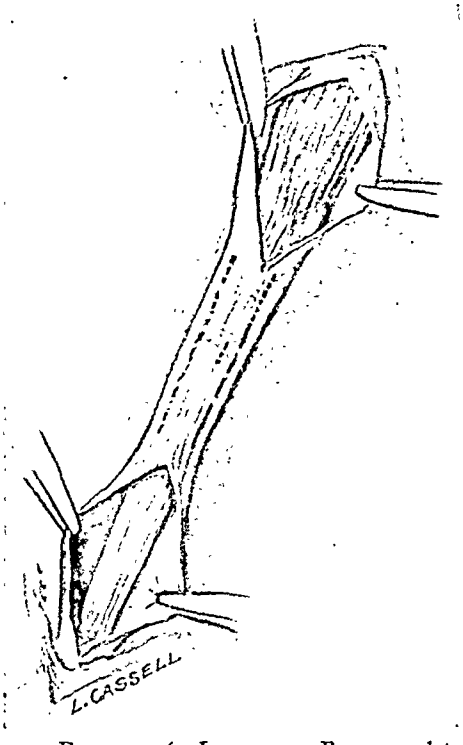


FIG. 4.—(92L, group B_1; complete immobilization, five weeks.) With continuous immobilization in a plaster encasement the tendon heals with a minimum of reaction. The sutures, now lying relaxed on the surface, are visible through the thin transparent sheath which allows the tendon to glide through it. The suture line is just visible, and there is no separation. Tensile strength 291.5 Gm.

Résumé.—Group B_1: The healing process when the leg is immobilized continuously in a plaster encasement, up to and including the fifth week, presents an orderly course of events. At two days, the tensile strength is very low, though not so low as it will be on the third or fifth day, and, certainly, much lower than the holding power of the tendon for the suture. The strength of union at this time, slight as it is, is due to the suture, but this strength is lower than the tested holding power of the fresh tissues for the suture. We can assume, therefore, that the healing process in the tendon is associated with softening of the tendon. Not only are the tissues across the line of union without any effective tensile strength, but the efficiency of the sutures themselves is very much diminished by the softening. This softening is progressive for several days, and on the third and the fifth days the tensile strength is still very low, and the sutures pull through the tendon stumps. However, on the fifth day both the holding power of the tendon and the

TABLE I

RÉSUMÉ OF EXPERIMENTAL DATA. FLEXOR TENDONS, GROUP B_1

Continuous Immobilization

No. of Dog	Day	Separation of Stumps. Mm.	Manner of Separation	Gross Pull. Gm.	Tensile Strength (In Gm. per Sq. Mm.) Computed	Estimated	Average
33R	2	1 5	3	1,815 0		160.6	
33L	2	0.0	2	113.4		5 9	
34R	2	2 0	2	907 0		41.3	
34L	2	0 5	2	907 0		41.3	
35R	2	5.0	2	453 6		24 08	
35L	2	0.0	2	907.0		77.0	58 19
66L	3	0 0	2	226.8	4 19		
67L	3	0 0	2	113 0	2 92		3.55
62L	5	6 0	2	340 2	11.46		
63L	5	2 0	2	340 2	10 24		
70L	5	0 0	3	680.4	27.94		
71L	5	0 0	2	226 9	6 38		14 00
36L	7	0 0	2, 4	453 0		20 63	
37L	7	1 0	2	283 5		12 89	
38L	7	1 0	2	171 0		7.73	
39L	7	1 0	3	737 0		33 53	
40L	7	1 0	3	1,475 0		147 4	44 00
44L	9	0 0	3	737 2	32 3		
56R	9	3 0	3	340 2	22 2		
57R	9	2 0	2	226 9	10 99		
98L	9	0.0	2	6,320 0	78.1		
100L	9	1 0	2	5,981 0	152.57		
109R	9	0 0	2	2,042 0	39 55		56.28
55R	10	1 0	2	1,598.0		72.7*	
86L	10	0 5	2, 4	2,495 0	61 7		
87L	10	2.0	2, 4	2,609 0	115 4		88 55
42L	12	1 0	2	1,134 0	89 58		
43L	12	1 0	3	1,984.0	63.08		
46L	12	0 0	2	1,474 1	123.1		91.92
52R	14	0 5	3	2,609.0	102.52		
52L	14	7.0	4	2,041.0	94 19		
53R	14	1.0	3	3,686 0	163.0		
53L	14	2 0	2	1,134 0	67.5		
80L	14	0 0	2, 4	4,593.0	98.54		
81L	14	0 0	4	6,920 0	187 4		
99R	14	0 0	3, 4	4,309 0	232.9		135.1
85R	15	1 0	3	1,921 0	52 9		52.9
63R	16	3 0	4	5,443.0	260.0		
82R	16	0 0	4	5,001.0	181.2		
83R	16	0 0	3	2,041.0	83.1		174.7

TABLE I (*Continued*)

No. of Dog	Day	Separation of Stumps. Mm.	Manner of Separation	Gross Pull. Gm.	Tensile Strength (In Gm. per Sq. Mm.) Computed	Estimated	Average
56L	19	5.0	4	2,382.0	102.5		
57L	19	0.0	4	3,744.0	175.2		
89R	19	0.0	2, 4	3,061.0	169.2		148.9
48L	21	5.0	4	5,330.0	235.6		
50L	21	0.0	1	5,445.0	199.9		
104R	21	0.0	1	1,824.0	85.0		
105R	21	0.0	3, 4	6,123.0	158.2		169.6
95R	28	0.0	1	5,699.0	179.2		
96R	28	0.0	1	4,196.0	209.2		
100R	28	1.0	4	4,599.0	209.1		199.1
46R	30	0.0	2	3,402.0	267.3		267.3
42R	35	0.0	2	2,042.0	210.9		
44R	35	1.0	3	666.4	61.9		
90L	35	0.0	1, 2	2,949.0	163.0		
92L	35	0.0	1, 2	7,145.0	291.5		
93L	35	0.0	1, 2	5,670.0	160.2		177.4

Key to Manner of Separation:

1—Fracture.
2—Separation followed by suture pulling through.
3—Separation followed by suture breaking.
4—Fracture with cuff.
5—Step-cut.
NB—No break.
MTJ—Rupture at musculotendinous junction.

* Not computed in averages.
* Segment only tested.
The key, and these footnotes, pertain to all tables where noted.

tensile strength are beginning to rise. On the seventh day these are still further increased. Not only does initial separation require a greater pull, but the sutures may occasionally break, as they do in the fresh tendon. By the tenth day we see striking evidence of the value of the surrounding tissues which now have formed a solid cuff about the stumps. In specimens up to seven days this tissue has been soft and easily ruptured; at ten days, it presents itself as a definite entity which is adherent to the stumps and binds them together. When separation occurs, this cuff of surrounding tissue strips away from one of the stumps and remains attached to the other. The cuff has been present all along; however, in the earlier stages it has been quite soft and has usually broken irregularly or with tags at the suture line (compare Fig. 2 A, B, C and D). At 14 days, the average tensile strength is slightly higher than at 12, but the gross pull required to separate is greater, and the cuff seems here to have reached its maximum. Although the cuff

tends to revert to gliding tissue some time between the fourteenth and twenty-first day, we may occasionally find it as late as the twenty-eighth (50R) and thirty-fifth day (45R). As the cuff becomes areolar or separates from the tendon between the fourteenth and nineteenth day, the tensile strength of the tendon seems to reach a sort of plateau. From the nineteeth day on, the tensile strength rises slowly until about the twenty-first day, when it reaches a second plateau which it tends to maintain for the following two weeks provided the leg is kept immobile in the plaster. Despite a tendency for a slight rise in the curve up to the twenty-eighth day, and a marked elevation in one specimen on the twentieth day, at 35 days, the average of five reasonably consistent specimens was lower than that for three equally consistent ones at 28 days, and practically equal to that shown at 21 days. The gross appearance of tendons immobilized four to five weeks has direct practical significance. They were seen to be beautifully healed (Fig. 4); the tissues about them were transparent and areolar and glided over the surface of the tendon, and the tendon itself glided through them. At five weeks, the gross appearance was that of a definite sheath. This sheath was slightly thickened over the operative area and was continuous with the perimuscular fascia above and the peritendinous fascia below. The line of apposition in some specimens was apparent as a thin pink or grayish seam, and the sutures were seen to lie on the surface of the tendon covered by a thin transparent layer of tissue. It had the appearance of primary union.

Group B_2 (Table II)

This group is made up of animals in which the plaster encasement was removed at the end of three weeks, and the dog had free and unhampered use of his leg until the tendon was removed.

Twenty-five Days.—At 25 days (54L) (tendon immobilized 21 days and free use four days). the operative area and tendon ends were found covered by a reddish-gray tissue through which the sutures were just visible. Where the tendon ends had fused, the tissue was homogenous and gray; the line of apposition was obscured. The tensile strength of this specimen was quite high—339 Gm. per sq. Mm. The specimen fractured at 11¼ pounds through a nick which had been accidentally made in it. It was not possible to locate this nick, and computation of tensile strength was made on measurement of the entire tendon, and it seems likely that the actual tensile strength was higher.

Twenty-eight Days.—At 28 days (immobilized 21 days and free use seven days), there are three specimens (48R, 50R, 51R), two of which we were able to fracture, while one (51R) could not be broken when subjected to a pull of 37 pounds. We do not know, therefore, what the actual strength of this tendon was, although it must have been well over 300 Gm. per sq. Mm., which would have been its tensile strength had it fractured at that time. In the two tendons which were broken, fracture occurred suddenly through the line of fusion; all structures including the embedded silk broke at once. One tendon (48R) broke at 13½ pounds with tensile strength of 318.5 Gm. per sq. Mm. The other (50R), a much larger tendon, broke at 33 pounds with a tensile strength of 297.9 Gm. per sq. Mm. A cuff was still present in one case, but it does not seem to be a very important element in the union since it could be easily stripped from the tendon to which it was attached by some fine adhesions. The tendon ends themselves were slightly bulbous and gray, and the sheath tissues over them gray and almost opaque, so that measurements were difficult.

Thirty Days.—At 30 days (58L) (21 days' splinting and nine days' free use), the tendon could not be ruptured with a pull of 29 pounds. True estimate of its actual tensile strength could not be made. However, computing its strength on the assumption that it had broken, it would have been 461 Gm. per sq. Mm., which it of course surpassed. There were some fine adhesions about it; it was thicker than normal; and showed more reaction than the continuously immobilized tendons.

Thirty-five Days.—At 35 days (41R, 98R, 101R and 102R), the stumps were bulbous and the sheath tissues moderately or markedly thickened. In one instance (41R) the dog was in poor general

condition, and in this specimen the healed defect and sutures were easily seen. Rupture took place through the intervening tissues with a pull of 13½ pounds, with a resultant tensile strength of 279.5 Gm. per sq. Mm. In another tendon (98R, Fig. 5) the union was large and bulbous, measuring 18x25 Mm. There was considerable bleeding when the subcutaneous tissues were separated from the outer layers of the sheath, and it was impossible to make the measurements. The entire specimen could not be ruptured, and two longitudinal strips were tested. The average tensile strength of these strips was 1,015 Gm. per sq. Mm. Both of the other specimens were also bulbous (Fig. 3 B) but not so markedly as 98R, and exhibited separations of 10 and 7 Mm., respectively. The manner of separation of the two differed, however. In 102R, rupture took place as a sudden fracture through the intervening tissues, while in 101R a step-cut type of rupture occurred, one-half of the tendon giving

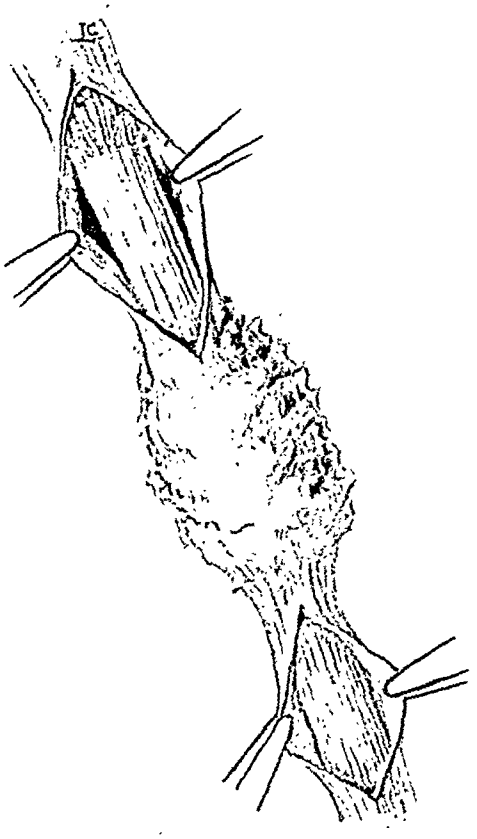


FIG. 5.—(98R, group B_2; complete immobilization, three weeks, active use, two weeks.) Large bulbous type of union occasionally seen when unrestricted active use is instituted after three weeks' rest in a plaster encasement. All structures thick and adherent. Sutures not visible. Bulb measured 18x25 Mm. Tensile strength 1,015.0 Gm.

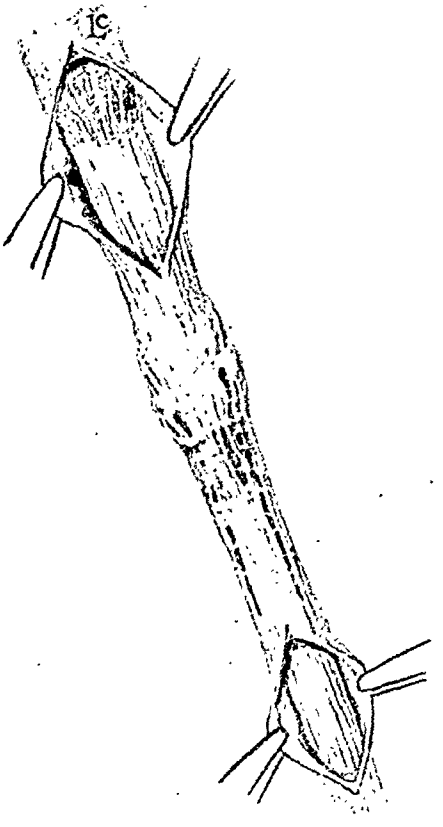


FIG. 6.—(103R, group B_3; 11 days' immobilization in a plaster encasement, ten days' unrestricted use. Dog had distemper.) A moderately bulbous union resulting from early unrestricted use after a short period of immobilization. Separation of stumps 7 Mm., but sutures lie relaxed on surface. Tensile strength 234.3 Gm.

way through the intervening tissues, the other half through the distal stump where it had been traversed by the suture.

Forty Days.—At 40 days (40R), with 21 days' rest in a plaster encasement and 19 days' unrestricted use, we have a single specimen. Here there was a local infection with marked reaction and with a sinus draining through the skin from one of the tendon sutures. The tendon, however, could not be broken with a pull of 20 pounds but rupture occurred at the musculotendinous junction. The actual tensile strength is not known since the tendon was not split to make this determination; however, its tensile strength was greater than that of the musculotendinous junction, which we estimate at approximately 321 Gm. per sq. Mm. There was here a separation of 10 Mm. between the stumps.

Forty-two Days.—At 42 days (36R, 37R, 38R, 39R) (plaster encasement for 21 days and free use for 21 days), it was not possible to rupture the new tendon with pulls ranging from 24½ to 34½ pounds. In all four specimens rupture occurred at the musculotendinous junction. We can obtain some idea as to the tensile strength of the tendon if we estimate that of the musculotendinous junction. On this basis the average tensile strength of the 42 day tendons should exceed 769 Gm. per sq. Mm. The sheath in all specimens, except that of 39R, had separated from the line of union and allowed

gliding of the tendon through it All of the unions were bulbous, especially 39R In this latter specimen, the sheath was fused and adherent to the tendon and to the surrounding tissues as well There was separation of 1 5 Mm in 38R, while 36R and 37R showed no separation

Sixty eight Days —One dog was observed at the end of 68 days (43R) (26 days' immobilization in a plaster encasement and 42 days' use) Infection had taken place, and a sinus was present which had led to a knot of the tendon suture The tendon itself was thick and edematous, as were all tissues about it However, this thickened tendon withstood a pull of 39¾ pounds before it ruptured at the musculotendinous junction A longitudinal segment of this tendon (after formalin fixation), with a cross sectional area of 3 958 sq Mm , was fractured across the line of union with a pull of 8½ pounds, with a computed tensile strength of 945 9 Gm per sq Mm

TABLE II

RÉSUMÉ OF EXPERIMENTAL DATA FLEXOR TENDONS, GROUP B_2

Continuous Plaster Encasement for Three Weeks, Then Active Use

No of Dog	Days		Separation of Stumps Mm.	Manner of Separation	Gross Pull. Gm.	Tensile Strength (In Gm. per Sq. Mm.)		
	Plaster Case	Free				Computed	Estimated	Average
54L	21	4	?	1	6,805 0	339 0		339 0
48R	21	7	4 0	1	6,123 0	318.5		
50R	21	7	?	4	14,970 0	297 0		308.2
51R	21	7	?	NB	16,780 0			
58L	21	9	2 0	NB	13,380 0			
41R	21	14	6 0	1	6,125 0		279 5*	
98R	21	14	?	5	5,475 0[s]	1,015 0		
101R	21	14	10 0	5	6,404 0	377 6		
102R	21	14	7 0	1	3,402 0	230 4		541 0
40R	21	19	10 0	MTJ	9,071 0			
36R	21	21	0 0	MTJ	12,929 0			
37R	21	21	0 0	MTJ	14,742.0			
38R	21	21	1 5	MTJ	15,650 0			
39R	21	21	?	MTJ	11,115 0			
43R	26	42	?	MTJ	3,742 0[s]	945 9		945 9

Résumé.—Group B_2: After active, unrestricted use has been started, following 21 days' immobilization, there occurs a rapid rise in tensile strength; whereby, on the forty-second day the strength of union is greater than that of the musculotendinous junction and is estimated (on basis of our statistics) at approximately 8 per cent of the normal tendon. By the sixty-eighth day, one specimen with a computed tensile strength of 945.9 Gm. per sq. mm. had reached approximately 10 per cent of normal strength, using our average figure for normal tensile strength of dog tendon of 9,386 Gm. per sq. mm.

The cuff of surrounding tissues which began to separate during the second week becomes converted into gliding tissue which allows the underlying tendon a certain amount of motion. We do not see as thin and transparent a sheath as in the completely immobilized tendons. The tendon ends are larger and more bulbous than in the immobilized tendons (Fig. 5), and the amount of separation, where it can be measured, is greater. There seems to

be no doubt that unrestricted active use after three weeks of rest results in a marked upswing in tensile strength. The strength, however, is obtained at the expense of increase in reaction in and about the tendon as well as in a greater separation of the stumps.

Group B_3 (Table III)

In 15 instances, the dog succeeded in removing his plaster encasement completely or partially and had unrestricted use of the leg after five to 16 days of immobilization for periods of from one to 21 days. Far from being a calamity, these animals afforded us the opportunity of making some very pertinent observations. In the first place, the reaction about the site of healing was the most marked of any in the series and the average separation of the stumps was the greatest (Table VI). In one instance (84R), after 15 days of immobilization the dog, a large 65-pound animal, suddenly removed his encasement one hour before the specimen was removed, and an acute traumatic rupture occurred through the site of suture. In three dogs (60R. 88R and 58R) the amount of reaction about the operative area was so marked that measurements could be made only with difficulty, and the amount of separation could not be determined until the specimen was sectioned. There was an average separation of 5.85 Mm., or five times that seen in the completely immobilized tendons.

Twelve Days.—At 12 days (47L) (plaster encasement 11 days and unrestricted use for one day), the tendon had a tensile strength of 203.9 Gm., or double the average (91.92 Gm.) of the 12-day immobilized tendons. There was, however, a separation of 7 Mm. between the tendon ends. There was a minimum of bleeding and reaction about the operative area, but the intervening tissues between the stumps were purple in color. Rupture occurred suddenly through the intervening tissues at the suture line with 8¼ pounds of pull.

Fifteen Days.—At 15 days (84R), there was one specimen in a dog, noted above, which had removed the encasement, one hour previous to removal of the tendon. An acute traumatic rupture had occurred, the sutures were broken, the tendon frayed, and the sheath tissues had fractured.

Sixteen Days.—At 16 days (60L, immobilized nine days, and 62R, 107R and 108R, immobilized seven days), all specimens showed a maximum reaction and separation of 5 to 7 Mm. (Fig. 3 D and E). Measurements in 62R were somewhat obscured by the reaction, part of which was due to associated infection. The tendon ends in all specimens were thickened and bulbous. The tensile strength of the tendons averaged 191.55 Gm. per sq. Mm.

Nineteen Days.—At 19 days (60R, 91L, 88R and 96L), a marked rise in tensile strength was seen to have taken place. Two of the specimens (60R and 88R) could not be ruptured, by our methods, through the line of union. One (60R, immobilized five days) broke through the musculotendinous junction with 43½ pounds of pull; while the other (88R, length of immobilization not definitely known) failed to rupture with 28½ pounds of pull. A third specimen (91L, immobilized 12 days) did not fracture when 40 pounds was applied. This tendon was then split longitudinally and a small segment was tested (3.18 sq. Mm. cross-sectional area) which ruptured at 5¼ pounds, indicating a tensile strength of 749 Gm. per sq. Mm. Specimen 96L (Fig. 3 C) was markedly thickened, firm, and adherent. It withstood a pull of 25 pounds before rupturing, but because of its size had tensile strength of but 221.3 Gm. A step-cut type of rupture occurred. These specimens, as had the 16-day ones, showed a marked reaction both within and about the tendon. The ends were bulbous and gray, and the sheath about them fused to the surface and markedly thickened. Although a strong union was produced, it did so at the expense of a clean, smooth one.

Twenty-one Days.—At 21 days (51L, 77R and 103R), all three specimens showed marked to moderate reaction in the tendon ends which were gray and bulbous and were united by gray tissue grossly resembling scar. In Dog No. 51L the proliferation in and about the reactive area had obscured the sutures; measurements were difficult; and a separation of 5 Mm. was present. The tendon could not be fractured when 20 pounds of pull was applied. After the tendon had been fixed in formalin, it was split longitudinally, and three segments were tested. One segment, of which at least three-fourths was thickened sheath tissue, showed a tensile strength of 255 Gm. per sq. Mm. The two others, made up largely of tendon with small amounts of surrounding tissue, had a tensile

strength of 439.5 and 347 Gm. per sq. Mm., respectively. The average for the three segments was 347 Gm. In Dog No. 77R (immobilized seven days and unrestricted use 14 days), there was a separation of 10 Mm., resembling that constantly seen in extensor tendons. The surrounding reaction was not marked, but the ends were bulbous and many adhesions were present. This tendon ruptured with a pull of 7 pounds, with a tensile strength of 106.8 Gm. per sq. Mm. Curiously enough, separation in this specimen occurred by the sutures' pulling out intact from the distal stump. A third specimen (103R), in a dog with distemper, showed a separation of 7 Mm. (Fig. 6); it fractured partly through the suture line and partly through one stump with a pull of 12½ pounds. Its computed tensile strength was 234.3 Gm.

Thirty-three and Thirty-five Days.—At 33 days (58R, immobilized 12 days and use 21 days), and at 35 days (45R, immobilized 14 days and free 21 days), the tendons could not be broken with 16½ pounds and 26 pounds, respectively. Both showed a maximum reaction and in both the tendon ends were fused by dense, tough gray tissue.

TABLE III

RÉSUMÉ OF EXPERIMENTAL DATA. FLEXOR TENDONS, GROUP B_3

Unrestricted Use

No. of Dog	Days: Plaster Case	Days: Free	Separation of Stumps Mm.	Manner of Separation	Gross Pull Gm.	Tensile Strength (*In Gm. per Sq. Mm.*): Computed	Estimated	Average
47L	11	1	7.0	1	3,744.0	203.9		203.9
84R	15	1 hr.	8.0	Traumatic				
62R	7	9	5.0	1	8,844.0	216.1		
107R	7	9	7.0	1	4,763.0[s]	196.9		
108R	7	9	7.0	4	3,459.0[s]	204.0		
60L	9	7	6.0	1	6,579.0	149.3		191.55
60R	5	14	8.0	MTJ	19,735.0			
96L	7	12	3.0	5	11,340.0	221.3		
91L	12	7	6.5	1	2,382.0[s]	749.0		
88R	18?	1	3.5	NB	12,925.0			485.0
77R	7	14	10.0	2, 4	3,175.0	106.8		
103R	11	10	7.0	5	5,670.0	234.3		
51L	16	5	5.0		9,074.0[s]	347.0		229.0
58R	12	21	3.0	NB	11,790.0			
45R	14	21	4.0	NB	7,486.0			

Résumé.—Group B_3: The significant observations in this group are that unrestricted use of the tendon is reflected in the curve of tensile strength, in the amount of reaction about the site of suture, and in the amount of separation which is found between the stumps. Because of the irregular periods of immobilization and use, and the inherent variability in tendon itself, the factors are difficult to correlate. One tendon, tested on the twelfth day with but one day's use, was significantly greater in tensile strength (203.9 Gm. per sq. Mm.) than any immobilized tendon tested at that time or until the sixteenth day, at which time the average tensile strengths for three immobilized specimens and three unrestricted use specimens were about equal (174 and 192 Gm. per sq. Mm.). At 19 days the tendon with unrestricted use (91L) showed a tensile strength of 749 Gm. per sq. Mm. In contrast,

the tendons under immobilization averaged about 150 Gm. per sq. Mm. tensile strength at 19 days and 170 Gm. at 21 days. In further contrast, a tendon continuously immobilized for 30 days showed a tensile strength of but 267.3 Gm., and five tendons immobilized for 35 days had an average tensile strength of but 177.4 Gm. per sq. Mm.

The amount of reaction which is observed about the tendons in this group stands in marked contrast to that seen where rest has been provided. This is reflected in a thickening of the surrounding tissues, which may obscure



FIG. 7.

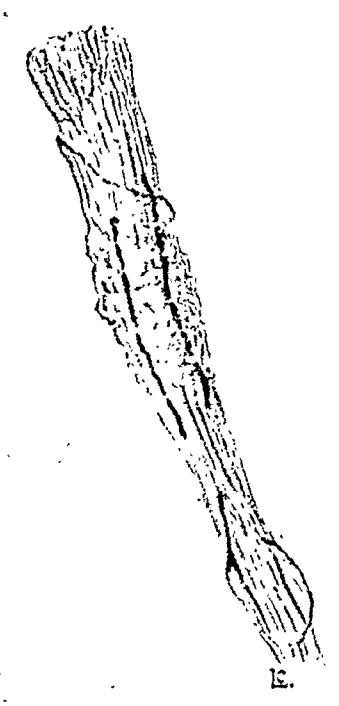


FIG. 8.

FIG. 7.—Photographs showing the method of providing for restricted use. A plaster encasement is applied from above elbow to include foot immediately after suture. Elbow and wrist held in flexion to relax the sutured tendon. At end of one week a portion of the encasement over pad of foot is cut away, allowing dog to flex foot, but extension is prevented by the aluminum splint which is incorporated in the plaster.

FIG. 8.—(106R, group B_1; complete immobilization, seven days; restricted use, in plaster encasement, as shown in Figure 7, for 12 days.) Minimal reaction about the operative area. The sheath is thin and sutures can be seen through it. The stumps are very slightly enlarged, and there has been no separation. The sutures are relaxed. Tensile strength 176.99 Gm.

the sutures, and in a bulbous enlargement of the tendon stumps (Fig. 3 C, D, E and Fig. 6). The average amount of separation is also greater where use has been allowed. Sudden unrestricted use at 15 days in a large 65-pound dog resulted in an acute traumatic rupture across the line of suture.

Group B_4 (Table IV)

In a few animals the following plan of splinting was carried out. An aluminum splint was incorporated in the initial encasement applied at time of tendon suture. At the end of one week of rigid immobilization the foot was freed and the dog permitted to flex it (Fig. 7). The aluminum splint prevented extension beyond the point at which it was originally immobilized. In a few animals, the encasement was removed under anesthesia and a fresh

one applied which fulfilled the same requirements, *i.e.*, allowed flexion but prevented extension beyond the angle at which the leg had been originally fixed. Tendons from these dogs were removed at intervals of 14, 16, 19, and 21 days following suture.

Fourteen Days.—At 14 days (72R, 73R, 74R and 76R), the line of union was visible in three of the specimens but obscured in the fourth (72R) by marked, grayish hemorrhagic tissue. This reaction, also present but in lesser degree in the other three specimens, had produced a thicker cuff than seen in the immobilized specimens. The tendon ends also had taken part in this reaction and were slightly thickened. In two specimens (73R and 74R) there was no separation at the suture line, while in one (76R) a separation of 3 Mm. was found. In two specimens (72R and 73R) when a pull was applied the stumps separated and the sutures pulled out at 8½ and 3 pounds, respectively. In 74R separation started at 9½ and was complete at 11 pounds with breaking of the suture. In 73R simultaneous separation of the intervening tissue and sutures occurred at 10 pounds. The average tensile strength for the four specimens was 125.6 Gm. per sq. Mm., approximately the same as for dogs completely immobilized for the same period of time.

Sixteen Days.—At 16 days (75R) with seven days' rigid immobilization and nine days' restricted use, the appearance of the union was good. The ends were fused in a gray cuff of tissue and there was but slight bleeding when the tendon was uncovered. It was somewhat difficult to measure the amount of separation, but it appeared to be about 2 Mm. The tendon ruptured with a gross pull of 15 pounds and exhibited a tensile strength of 295 Gm. per sq. Mm. Separation occurred when the intervening tissue fractured, and the sutures broke. The cuff of surrounding tissues remained attached to the distal stump (compare Fig. 2 F).

Nineteen Days.—Two quite disconcerting specimens were encountered at 19 days (106R—Fig. 3 F and Fig. 8; and 95L—Fig. 2 E), in that computations for tensile strength gave such divergent results and were much lower than had been anticipated from the preceding and succeeding specimens. Dog No. 106R presented a very satisfactory picture of healing by primary intention. The stumps were only slightly enlarged, there was a thin movable sheath which allowed the underlying tendon to glide beneath it, and all sutures including the fine approximating sutures were clearly visible. It ruptured by fracture through the suture line with a pull of 12⅜ pounds and had a computed tensile strength of 176.99 Gm. per sq. Mm. Dog No. 95L also exhibited but moderate thickening of the stumps. However, the tendon glided rather poorly through the sheath. The sheath itself was thick and adherent to the tendon and surrounding tissues. Separation occurred with a pull of 12$\frac{15}{16}$ pounds. The heavy sheath brought the cross-sectional area of this tendon up to a figure approximately that of a human Achilles tendon. Rupture in both of these specimens (Fig. 2 E and F) occurred through the suture line, the proximal stump pulling away from the distal, leaving the thickened sheath attached to the distal stump. The thick sheath added to the cross-sectional area but contributed very little to tensile strength.

Twenty-one Days.—At 21 days (78R), the tendon was seen to be firmly united by a thin line of gray tissue 1 Mm. wide. The sheath was gray but transparent and glided over the surface. Separation of the stumps occurred by sudden step-cut fracture at 15½ pounds, with a tensile strength of 699.3 Gm. per sq. Mm.

TABLE IV

RÉSUMÉ OF EXPERIMENTAL DATA. FLEXOR TENDONS, GROUP B4

Restricted Use

No. of Dog	Days: Plaster Case	Days: Use	Separation of Stumps Mm.	Manner of Separation	Gross Pull Gm.	Tensile Strength (In Gm. per Sq. Mm.): Computed	Estimated	Average
72R	7	7	?	2	3,856.0		119.0*	
73R	7	7	0	2	1,376.9	53.71		
74R	7	7	0	1, 4	4,309.0	130.62		
76R	7	7	3	4	4,536.0	192.6		125.6
75R	7	9	2	1, 4	6,803.0	295.0		295.0
95L	7	12	0	1, 4	5,883.0	84.75		
106R	7	12	0	1, 4	5,614.0	176.99		130.8
78R	7	14	1	1	7,003.0	699.3		699.3

Résumé.—Group B_4: The reaction at the site of operation and the amount of separation were less in these tendons with restricted use than in those which had had uncontrolled use before the three-week period had ended. However, the reaction was more marked than had been observed in dogs under complete immobilization. The amount of separation, however, was less than in the completely immobilized group (Table VI). At two weeks, when the first observation was made, the average tensile strength was practically the same as that for completely immobilized dogs. The manner of separation of the stumps at the time of rupture was also the same as that of completely immobilized tendons; that is, the stumps separated through the intervening tissue leaving a cuff of proliferated surrounding tissue attached to one of them.

Two specimens, one at 16 days and one at 21 days, had high tensile strengths. In the case of the 16-day specimen (75R), which separated with a cuff, 15 pounds' pull was required to rupture it, with a tensile strength of 295 Gm. per sq. Mm. This is somewhat higher, but not greatly so, than the highest of the three 16-day specimens with complete immobilization. The 21-day specimen (78R) presented a fine, clean-looking union with 1 Mm. separation; a minimal reaction; and covered by a gliding sheath. It required 15½ pounds to rupture it, and it was computed to have a tensile strength of 699 Gm. per sq. Mm. The tendon ruptured, however, not at the suture line but at a place where the tendon was traversed by the silk. While this figure of 699 Gm. per sq. Mm. is a single one, it is much higher than any of the 21-day specimens which were completely immobilized and even higher than a 25-day specimen with three weeks' immobilization and 4 days' use.

Two 19-day tendons, however, had the same tensile strength that was shown by completely immobilized tendons of the same age. It seems quite evident that function has influenced the tensile strength curve but that the effect is manifested only in the third phase of healing, *i.e.*, during the second period of increase of tensile strength.

Extensor Tendons (Table V)

Sixteen extensor tendons were sutured and examined at intervals of 2, 14, 21 and 42 days. The series is quite small, and our calculations as to tensile strength in all of them have been based upon an estimated cross-sectional area derived from a measurement of the width of the tendon at time of removal. However, in the course of our experimental studies during the past few years, several hundred extensor tendons have been operated upon, and while tensile strength figures are lacking in these, our general observations in this larger group substantiate the findings made in the present smaller series.

Two Days.—At two days after suture (25R and L, 26R and L, 29R and L, 30R and L), three specimens (25L, 29L and 30L) exhibited no evidence of union, while in the other five, despite wide separation, the ends were held together by a soft, gelatinous hemorrhagic clot. The reaction about the site of union was quite marked especially when compared with two-day specimens in the flexor series. There was marked separation of the stumps at the suture line, a phenomenon which seems to occur, almost invariably, following suture of this tendon. We have not been able to overcome this separation by any methods of suture so far tried. It has been less with the type of suture here described than with any other thus far used. We cannot say whether this is a phenomenon of extensor tendons in general or is due to our inability to immobilize the dog's foot adequately. At two days, the separation varied from 12 to 20 Mm., and averaged 15 Mm. The sutures, with this amount of separation, have, of course, either broken (29R) or pulled partially or completely (25R and L, 29L) through one or other of the stumps. In one instance (30R) the sutures had pulled partially through both stumps and in doing so had pulled a core of tendon from the center of the proximal stump. Very little holding power of the sutures is manifest. The initial separation occurred at an average gross pull of 201 Gm. Separation of stumps with pull-out of sutures occurred in three instances (26R, 30R, 30L) at 2 pounds 3 ounces, 2½ pounds, and 1 pound, respectively. The suture-holding power of the tendon is very low, even lower than in the flexor group. At two days, the average holding power of the tissue for the suture in the flexors was 3 pounds 2 ounces; whereas, in the extensors it was 1 pound 1 ounce. Initial separation of the stumps in the flexors occurred at 1 pound 14 ounces; in the extensors it averaged just under 6 ounces.

Fourteen Days.—At 14 days (31L), the stumps were united by a reddish-gray tissue through which the sutures were still visible. There was a separation of 18 Mm., but the sutures had not pulled completely out of the stumps and were held moderately firmly. Fracture through the intervening tissue occurred suddenly at 6½ pounds with simultaneous fracture of one suture and of intervening tissue. At the same time the other suture pulled out of the distal stump intact. The tensile strength of this specimen we have estimated at 129.8 Gm. per sq. Mm.

Twenty-one Days.—At 21 days (27L, 28L, 32L), the separation between the stumps was 17, 34 and 26 Mm., respectively. Despite this amount of separation and the great amount of reaction present, the tendons functioned well; that is, when the other extensor tendons were divided, pull upon the sutured extensor carpi radialis extended the paw to 180°. Rupture occurred in three different manners in the specimens and at quite different amounts of gross pull. In one (27L), the sutures pulled out of the distal stump at 2¾ pounds, bringing with them a small fragment of the stump. In another (28L), sudden fracture of the intervening tissue and the suture occurred at 10½ pounds. In the third (32L), sudden fracture through the intervening tissues occurred at 17½ pounds, but this time the frayed, red, thick distal stump pulled away from the proximal stump as if from a socket formed by the thickened sheath tissues. Despite the great difference in gross tensile strength the estimated strength of the three was but 105.9, 151.6 and 168.1 Gm. per sq. Mm., with an average of 141.8. The average separation of the three 21-day specimens was 25.6 Mm.—almost double that of the two-day specimens.

Forty-two Days.—At 42 days (27R, 28R, 31R and 32R), strong tendons had developed except in one specimen (28R), in which the sutures had pulled out and there was no union at all. The separation for the four tendons including the one in which no union had occurred was 34 Mm.; however, in one instance there was but 10 Mm., while in the others it was 45, 50 and 30 Mm. The reaction in the specimen showing but 10 Mm. separation was very minimal, the stumps were only slightly bulbous and appeared continuous with the intervening tissues. This tendon glided well and extended the forepaw to 180°. When subjected to 40 pounds of pull it ruptured through the musculotendinous junction, and when retested it slipped out of the forceps at 53 pounds. Estimated tensile strength based on this latter figure would exceed 1,276 Gm. per sq. Mm. The other two tendons ruptured through the intervening tissues, one at 25 pounds of pull, the other at 20 pounds. The amount of reaction about the operative area, however, produced a thick, heavy mass of tissue which, while able to withstand considerable gross pull, possessed very low tensile strength per sq. Mm.—240.5 and 110 Gm. (estimated), respectively.

Résumé.—Extensor Tendons: Healing in the case of the extensor tendons occurs despite the great amount of separation which obtains. This separation appears to be progressive in nature and is greater at six weeks than at three weeks or at two days. The holding power of the tendon for the sutures diminished more rapidly in the case of the extensors than the flexors and at two days is only about one-fifth of that which was present immediately after the suture. Even at 21 days, suture pull-out may occur. Our observations

seem to indicate that the curve of wound healing in the case of the extensors resembles that of the flexors but that it progresses at a slower pace.

Discussion.—The curve of healing for sutured tendons, as measured by return in tensile strength, appears to be similar to that for healing in other tissues. However, the process, when observed beyond the stage of fibroplasia, seems to respond or react in a definite manner to functional demands put upon it. If we take as a gauge simply the return of tensile strength, we are apt to ignore certain other effects of motion upon the healing process, the disadvantages of which may far outweigh the advantages of a rapid increase in strength. There is no doubt but that we have in function a valuable aid

TABLE V

RÉSUMÉ OF EXPERIMENTAL DATA. EXTENSOR TENDONS

No. of Dog	Day	Separation of Stumps Mm.	Manner of Separation	Gross Pull Gm.	Tensile Strength (In Gm. per Sq. Mm.) Computed	Estimated	Average
25R	2	12	1	28.35		1.71	
25L	2	15	No union				
26R	2	13	2	56.7		4.81	
26L	2	13	2	696.5		44.95	
29R	2	15	2	113.4		5.19	
29L	2	20	No union				
30L	2	17	No union				
30R	2	16	2	113.4		9.63	13.25
31L	14	18	2	2,835.0		129.8	129.8
27L	21	17	2	1,247.0		105.9	
28L	21	34	1	4,763.0		151.6	
32L	21	26	2	7,940.0		168.1	141.8
27R	42	10	NB	24,005.0			
28R	42	45	No union				
31R	42	50	1	11,340.0		240.5	
32R	42	30	1	9,071.0		110.0	175.0

in healing, but it remains to be determined how and when to make use of it.

The answer as to when function is effective in the healing process of tendon may be suggested by a study of the curves of tensile strength of the various groups of tendons (Chart 1).

During the first four or five days after suture the gross tensile strength of the sutured tendon drops to considerably less than that found to be present immediately following operation. During this time the ends become soft and are held together by a gelatinous exudate, which possesses a very minimum of tensile strength. Along with this, the softened stumps have considerably less holding power for the sutures than was present when they were intro-

duced, and when stress is applied the sutures instead of breaking simply pull out. Beginning about the fifth day there is noted an increase in tensile strength which continues until the fourteenth to sixteenth day when the strength in most specimens seems to have reached a plateau where it remains until about the nineteenth day, when a second plateau is reached about the twenty-first day, and this is maintained for the next two weeks. Whether or not we are dealing simply with a delay in healing, *i.e.*, in the progress of

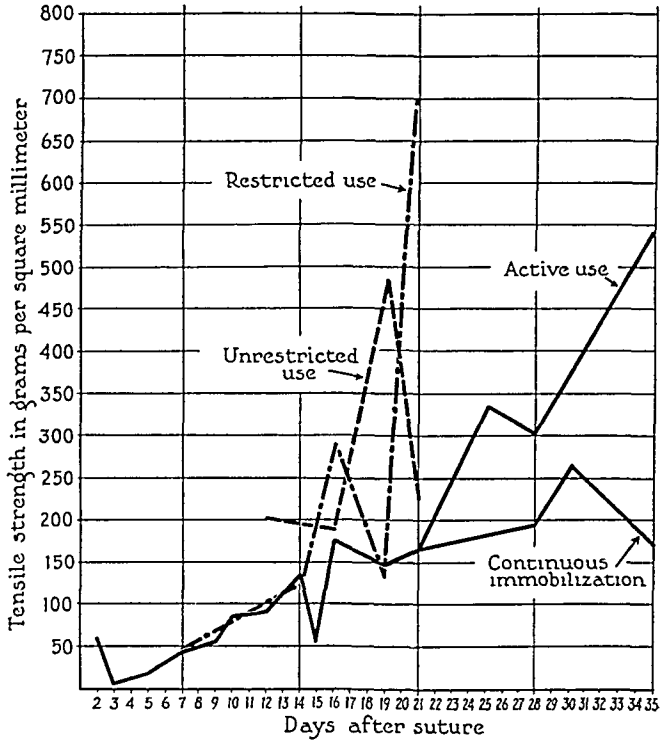


CHART 1.—Tensile strength in grams per sq. Mm. of healing flexor tendons from two to 35 days following suture. The lower, continuous curve, group B_1, represents tendons continuously immobilized. The curve for group B_2 represents tendons immobilized for three weeks and then subjected to immediate active use; it branches off of the group B_1 curve on the twenty-first day. Tensile strength values for tendons subjected to either unrestricted or restricted use, groups B_3 and B_4, are plotted up to 21 days only.

differentiation, we cannot say since our observations on continuous immobilization do not extend beyond the 35-day period. It may be that despite immobilization the tensile strength will slowly approach that of normal tendon; however, the rather consistently lower figures for tensile strength obtained at five weeks suggest that the line of union may show atrophy of disuse. Disuse may be a more important factor in tendon healing than studies based on histologic sections seem to indicate. Immobilization in a plaster encasement, however, does not put the muscle entirely at rest; tension and tonic pull are undoubtedly present, and these factors must act upon the healing tendon as a functional stimulus.

When there is introduced into the process function and tension greater than that afforded by muscle tone and the motion possible with splinting, the curve of healing is changed; and the tensile strength mounts more rapidly. This is evident if we compare the curve of the tensile strength values obtained in tendons allowed unrestricted use after three weeks in a cast. It rises sharply from the plateau of about 200 Gm. per sq. Mm., and at the end of one week of use is already 50 per cent stronger than immobilized tendons of the same age. We do not believe that this finding is due simply to the great variability of tendon tissue since the same tendency to more acceleration of the curve is also evident in the two other groups of animals in which a functional stimulus was present.

In those instances in which the encasement was removed by the animal, and free, unrestricted use was started earlier than three weeks, the same tendency to abrupt rise in tensile strength is noted. However, it is important to note that this rise in tensile strength does not occur until a certain stage in healing has been attained. At 16 days, both the mobilized and the immobilized tendons have approximately the same average tensile strength. At 19 days, however, the used tendons are very strong in comparison with immobilized ones. This rise manifested at 19 days has not been observed in the 21-day specimens, and there would appear to be a contradiction present. The group of animals here concerned had removed their encasements and had used the operated leg without restriction; so that while we have the element of function entering in, it has consisted of violent use. It is of interest to note that the amount of separation in the three 21-day tendons varies inversely with their tensile strength. Thus, the tendon with but 5 Mm. separation had tensile strength of 347 Gm. per sq. Mm.; that with 7 Mm. separation had a tensile strength of 234.3 Gm.; while that with 10 Mm. separation had a tensile strength of but 106.8 Gm. The number of days which the tendons had been immobilized varied directly with the tensile strength; with 16 days' immobilization the strength was 347, with 11 days, 234.3, and with seven days, 106.8. No definite conclusions are permissible, but the findings are suggestive, and the general tendency for these tendons to arrive at very high tensile strengths seems to us evident.

Similar observations were made upon the group of dogs which were allowed restricted motion after one week of rigid immobilization. Four specimens, examined at 14 days, showed a tensile strength the same as that for the immobilized dogs. At 16 days, and especially at 21 days, however, the strength was well above that for the immobilized specimens. In these animals function in the form of flexion of 10° to 15° had been permitted from the seventh day after operation. However, it had produced no change in tensile strength up to 14 days. After this time, however, the tensile strength curve while inconsistent is different from that of the completely immobilized group. The drop at 19 days in the restricted tendons and at 21 days in the unrestricted ones cannot be explained. However, the fact remains that the only

tendons which attained high levels of tensile strength during the five-week period of observation were those in which a functional stimulus was present.

There are, of course, many other factors which have to do with healing besides that of function; in fact, it is commonly conceded and has been abundantly illustrated that rest and quiet are necessary for good wound healing and that motion and activity retard the process. We must inquire, therefore, if there is a certain phase in the healing process of such a structure as tendon

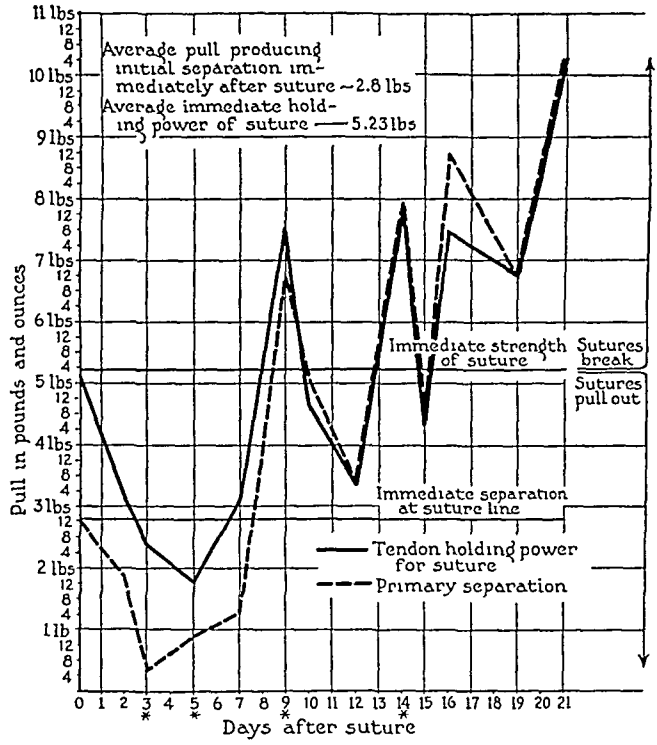


CHART 2.—Showing the holding power of tendon for suture and tensile strength of sutured tendon in pounds per tendon.

when use and motion are actually harmful and another phase when they may be beneficial. We should know, also, whether this marked increase in tensile strength may not be obtained at the expense of other more important desiderata.

If we compare the curves for tensile strength of the completely immobilized tendons with the curves for restricted and unrestricted motion, it is seen that at the 14- and 16-day period of observation the same tensile strength was present in all three groups. After 14 to 16 days we see, however, that the tensile strength increases more rapidly in those tendons which had been subjected to some degree of function. It would seem logical to conclude, therefore, that function has very little effect upon tensile strength of the union previous to the fourteenth or sixteenth day. Our observations indicate, therefore, that, granted that function were a valuable aid to the

healing of tendons, so far as tensile strength is concerned it does not exert its influence before approximately two weeks after suture. The tendon kept completely immobile for two weeks, that with a limited period of rest and unrestricted use, and that with restricted use arrive at the 14-day stage with about the same tensile strength. Function exerts its influence during the second phase of increase in strength, the period of maturation or organizing differentiation of the tendon. This starts, as previous histologic studies have shown, about the fourteenth to sixteenth day, and is manifested in tensile strength experiments by a tendency for the curves of all tendons to begin to rise after the sixteenth day.

The holding power of the tissues for the suture is also of significance here and has a direct bearing upon the problem as to when motion should be started. In Chart 2 are plotted two curves. One curve represents the amount of pull in pounds required to produce initial separation of the sutured tendon ends. Size of tendon and cross-sectional area are not taken into consideration. The other curve represents the amount of pull in pounds necessary to pull the suture out of the tendon or to break the suture. To arrive at base lines for this chart, a number of tendons were sutured with No. 8 Champion, twisted, untreated silk and were immediately subjected to pull. At an average pull of 2.8 pounds the tendon ends began to separate slightly, and at an average pull of 5.23 pounds separated completely. Separation occurred in every instance by the sutures breaking at the knot. Lines are drawn across the chart at the level of 2.8 and 5.23 pounds and represent the immediate strength of a sutured tendon.

As Howes has shown for fascia, the immediate strength of the sutured tendon depends upon the functionating strength of the suture. It is evident that we are not taking advantage of the entire holding power of the tendon and that a heavier suture would be necessary to do so. We have not tried to determine the ultimate holding power with our method of suturing since as far as our present work is concerned, this would necessitate the use of heavier sutures. As a matter of fact, the suture we have used is heavier than necessary as may be noted in Chart 2.

During the first ten to 14 days after operation the sutured tendon separates in a consistent manner. As pull is exerted upon the stumps, separation first occurs across the line of union but the stumps are still held together by the suture. With increasing pull the sutures give way by pulling through the stumps and separation is complete. Following the fourteenth day, separation of the stumps is usually associated with a breaking of the sutures. There is an occasional pulling-out of the sutures after 14 days, and an occasional breaking of the sutures before 14 days, but the variations are no greater than would be expected.

Examination of Chart 2 shows that both the curve for primary separation and that for tendon holding power drop precipitously. The curve for primary separation which really represents tensile strength of the union

falls on the second day to under 2 pounds and on the third day to about 6 ounces. On the fifth day the tensile strength has started to rise and by the ninth day crosses its theoretic base line below which it does not subsequently drop. The curve for tendon holding power for the sutures starts at 5.2 pounds, but by the second postoperative day has dropped to slightly over 3 pounds. This actually represents holding power since final separation occurs not by fracturing, as obtains immediately after suture, but by the sutures' pulling out of the stumps. This curve drops to its lowest level on the fifth postoperative day, a time which coincides with the period when fibroplasia and tendon proliferation begin. After the fifth day the holding power mounts but it does not cross the base line of 5.2 pounds until some time between the twelfth and fourteenth days. After this time, although there is an occasional suture pull-out, fracture of the union is usually associated with breaking of the sutures. Chart 2 is based entirely on tendons immobilized for from two to 21 days.

These observations indicate not only that the tensile strength of a sutured tendon is extremely low for a number of days but also that the holding power of the tendon tissues drops just as rapidly. We cannot rely upon the line of union possessing the strength immediately afforded by suturing but must reckon with a significant drop in this strength. We agree with Howes that "the loss of strength of a wound was not caused by the loss of tensile strength of the suture material alone but rather by the change of all the factors which determine the strength of the wound during the latent period." We realize that moisture and exposure to tissues tend to lower the tensile strength of silk, factors which have been recently stressed by Shambaugh, and Meade and Ochsner. However, it is our feeling that the significant loss in strength in union in sutured tendon is not due to weakening of the suture itself but to softening of the tissues and diminution in holding power for the suture which occur in the early stages of wound healing. It would seem unwise to initiate function during the time both tensile strength and holding power are dropping, and quite hazardous to allow pull of any magnitude before the tendon has regained its suture holding power. So far as strength of union is concerned, the data derived from holding power of sutures and gross tensile strength of union would indicate that use should not be allowed before the tenth day and probably not before the fourteenth day.

The observations on tensile strength following suture of the extensor tendons suggest that they regain their strength more slowly than do the flexors. It seems logical to assume that this retardation in the curve is in some way associated with the separation which is invariably present between the stumps of sutured extensor tendons. This is borne out by the fact that the separation is progressive. At two days, the average separation of the extensors is 15 Mm., at three weeks, it is 25.6 Mm., and at six weeks, it is 34 Mm. Of the four six-week specimens there was one with a separation of but 10 Mm., and this was firmly healed with a minimum reaction. Its

tensile strength was greater than that of its musculotendinous junction. The other three specimens had separated 30, 45 and 50 Mm., respectively. One had not united, and the other two had healed with marked reaction. These latter tendons ruptured through the tissue intervening between the stumps at estimated tensile strength of but 110 and 240 Gm. per sq. Mm. The evidence points to the fact that a large gap gains strength slowly and is liable to stretch for a long period of time.

It is instructive to compare the amount of separation which occurs during healing in the four groups of flexor tendons (Table VI). In Group B_1, in which complete immobilization has been maintained during the whole period of observation, separation of the stumps was usually less than 1 Mm., and the average for all specimens was 1.07 Mm. When active use is begun after three weeks' immobilization (Group B_2) the amount of separation increases so that it averages 4.44 Mm. In those animals that removed their plaster encasements and used their legs without restriction earlier than three weeks after operation (Group B_3), the separation averaged 5.85 Mm. The ob-

TABLE VI

SEPARATION, IN MILLIMETERS, BETWEEN TENDON STUMPS; CLASSIFIED ACCORDING TO GROUP AND DAYS FOLLOWING SUTURE

	Days after Suture						Average Separation
Group	2	7	14	21	35	42	Mm.
Flexor B_1	1.5	1.23	1.15	1.2	0.2		1.07
B_2					5.7	2.9	4.44
B_3			7.0	5.66	4.0		5.85
B_4			1.0	0.75			0.85
Extensor	15.1		18.0	25.6		33.8	21.3

servations suggest that, regardless of the minimal amount of separation, unrestricted use, even after three weeks of complete rest, results in some further separation. It we compare with these three groups of tendons our small series of animals in which restricted motion was permitted (Group B_4), we find, here, not only very strong tendons but a minimum of separation. Here, the average separation was 0.85 Mm., slightly less than that in the completely immobilized dogs. Further observations are needed in the case of the tendons with restricted use, and it remains to be seen whether they will continue to exhibit less tendency to stretch after three or more weeks. The results to date seem to indicate that the intervening tissue between the stumps is stronger and more resistant to stretching at the end of three weeks with restricted use than in those tendons which have been kept completely immobile for a similar period of time.

The amount of reaction about the site of suture varies with the time of

onset and nature of functional use. During the early stages of repair there is, of course, a great increase in the circulation in and about the tendon; the subcutaneous tissues and the peritendinous tissues become edematous and vascular, and the whole operative area is fused into an easily bleeding soft gelatinous mass. The effect of motion on this early stage is demonstrated particularly well in the extensor tendons where marked separation and bulbous thickening of the stumps seems to be characteristic of the manner of healing of these tendons. Such reactions, however, are noted in the flexor series where active motion comes into play (Fig. 3 B, C, D, E and Figs. 5, 6 and 8). One can usually judge the degree of activity by the appearance of the stumps. Where the tendon has been completely at rest all reactions are reduced to a minimum. When such tendons are uncovered at the end of four or five weeks, the site of union is covered by a thin transparent sheath beneath which all sutures are visible (Fig. 4). The narrow line of apposition of the stumps may be just visible as a grayish or pinkish seam. The tendon itself is only slightly if any larger than when operation was performed and has regained entirely the mother-of-pearl sheen which it loses to some extent during the early stages. Where restricted motion has been permitted, there is some increase in the thickening of the sheath, the ends of the tendons are thickened for a slightly longer period of time, but the tendon and sheath tissues usually separate easily from the tendon after the nineteenth day (Figs. 3 F and 8). Active unrestricted use, however, even after a full three weeks of complete immobilization (Figs. 3 B and 5), leads to bulbous proliferation at the site of union, and afterwards to fibrous adhesions between the stumps, sheath, and surrounding tissues. Such marked reaction, as shown in Figure 5, does not always occur, but it happens with sufficient frequency that there is no question but that active unrestricted use is accountable. At times even where active use has started quite early, the amount of reaction is only moderate (Fig. 6); however, we notice in these tendons the almost invariable presence of separation (Fig. 3 D and E).

The observations made on this series of tendons would seem to show that peritendinous adhesions and reaction are definitely related to use. Excessive activity even after an immobilization of three weeks may convert a clean union into a bulbous adherent mass and cause increase of separation at the line of union. We cannot say definitely from our experimental data, thus far, whether or not unrestricted use after five weeks of immobilization would lead to stretching at the suture line, but the indications are that it would do so. Our results seem to show, however, that restricted use, while it leads to somewhat more reaction than occurs with complete rest, still does not lead to excessive reaction or cause separation. In all our animals with restricted use the period of initial complete immobilization was but seven days, and our series has not extended beyond a period of three weeks. They might also exhibit bulbous enlargements and stretching if active use were permitted after 21 days. Since, however, the tendons in this group tend to be some-

what stronger than immobilized tendons, it is not unlikely that because of increased tensile strength they would be better able to withstand functional demands.

Motion is started early following tendon repair because of the fear that binding adhesions will develop. We feel that unrestricted use must be instituted late in the process and should always be preceded by active, guarded motion. Too early use of any sort is liable to lead to marked reaction and thickening which may defeat the very purpose for which it is instituted. Gliding of the healing tendon we have observed to appear in the natural course of events of the healing process. Tendons kept completely immobilized develop excellent gliding sheaths. Too early activity will not insure gliding but on the contrary will lead to increased reaction. Similarly unrestricted use even after long immobilization may cause enlargement of the tendons, stretching of the line of union and adhesions.

SUMMARY.—A series of experiments has been carried out on the manner of healing of sutured tendons. Observations have been made on the rate of increase in tensile strength, on the effect of function on this rate of increase and on other phases of healing, and on the holding power of the tendon for sutures.

The curve for increase in tensile strength conforms to similar curves for other tissues, in that following an initial drop there is a rapid increase in tensile strength which reaches a plateau between the fourteenth and sixteenth day. This level is maintained for several days in the completely immobilized tendon until about the nineteenth day, when a slight rise occurs and a second plateau is reached which is maintained for the next two weeks. In those instances in which the plaster encasement was removed at the end of 21 days and active use of the extremity permitted, the tensile strength showed a marked rise in value over that of the immobilized specimens. In instances in which unrestricted active use of the extremity occurred earlier than the third week of healing, the tensile strength values tended to rise significantly above those of the immobilized tendons. Similar higher values for tensile strength were found in animals in which restricted or guarded use of the sutured tendon was permitted from the seventh postoperative day on. However, in these latter two groups the effect of function is not manifest until after the fourteenth day and the evidence seems to favor the conclusion that function leads to an acceleration of the phase of maturation.

Observations on the holding power of tendon for sutures have shown that, with our method of suturing and with the size of silk suture employed, the immediate strength of the suture line depends upon the strength of the silk. Immediately following suture, the union withstands a pull of 5.23 pounds before the silk ruptures and separation occurs. The holding power of the tendon for the suture is greater than the strength of the suture material used. However, this holding power rapidly and progressively diminishes and by the second postoperative day the sutures pull out of the tendon. The holding power

reaches its lowest level on the fifth day, after which it rises above the level of the strength of the suture. This rise is not consistently maintained, however, until after the fourteenth day. The tensile strength of the union, which also drops, reaches its lowest level on the third day, and by the fifth day is already on the increase. By the ninth day the tensile strength of the union approaches the holding power of the tissues for the suture. Following the ninth day the two curves are practically identical; that is, the separation of the stumps and giving way of sutures usually occur simultaneously.

The amount of separation between the tendon stumps varies directly with the amount and type of function to which the union is subjected. The least amount of separation occurred in flexor tendons which were completely immobilized or completely immobilized for one week and allowed restricted use thereafter. The greatest amount of separation was observed in those tendons which were subjected to early active use and in the extensors.

The degree of reaction about the sutured area also varied directly with the amount and type of function to which the tendon had been subjected.

It is interesting to note that the sequence of events of tendon healing follows a definite chronologic order, whether these observations are made on functional return (Stewart), metabolic changes (Gaza, Gerlach and Gissel), or from the standpoint of histology or return in tensile strength.

CONCLUSIONS

(1) Tendon healing as measured by its tensile strength exhibits three phases:

A. Phase of rapid diminution, which lasts about five days.

B. Phase of increase in tensile strength up to a plateau, which it reaches about the sixteenth day.

C. Second phase of increase in tensile strength, which probably starts between the nineteenth and twenty-first day and continues for an undetermined period of time.

(2) Curves of tensile strength conform to phases observed in histologic process of repair:

A. Phase of exudation and fibrinous union.

B. Phase of fibroplasia.

C. Phase of maturation or organizing differentiation.

(3) Function to which the healing tendon is subjected is directly reflected in the curve of the third phase of healing. During the first and second phases it produces no effect unless it is so great as to cause marked separation. During the third phase of healing function accelerates the curve.

(4) Function and motion during the first two phases of healing lead to increased reaction and to separation at the suture line. Restricted use of the tendon, started on about the fourteenth day and continued for one week, or preferably two, may be expected to lead to only a slight increase in reaction and to a rapid increase in tensile strength of the union. Active unguarded

use even after three weeks of immobilization may be associated with stretching of the suture line and always leads to increase in reaction.

(5) The holding power of tendon for the suture shows a marked drop below its original power and does not begin to rise until the fifth day after suture. It does not rise consistently above the strength of the sutures until the fourteenth day. Although the strength of union for the first nine days is essentially due to the suture, it is not so great as the immediate sutured strength until after 14 days. The importance of adequate relaxation during this time is evident.

BIBLIOGRAPHY

[1] Biesin, A.: Experimentelle Untersuchungen über die Heilung der Sehnenwunden. Ztschr. f. orthop. Chir., 55, 186–221, 1931.

[2] Carrel, A.: The Treatment of Wounds. J.A.M.A., 55, 2148, 1910.

[3] Carrel, A., and Hartmann, A.: Cicatrization of Wounds. Jour. Exper. Med., 24, 429, 1916.

[4] Carrel, A.: The Process of Wound Healing. Proc. Inst. Med., Chicago, 8, 62–66, 1930–1931.

[5] Clark, A. H.: Effect of Diet on Healing of Wounds. Baltimore, Bull. Johns Hopkins Hosp., 30, 117, 1919.

[6] Cronkite, A. E.: The Tensile Strength of Human Tendons. Anat. Rec., 64, 173–186, 1935–1936.

[7] DeBernardis, M.: La guaina tendinea e sua importanza nei processi guarigione della ferite dei tendini e nulla prevenzione delle aderenze peritendinei postoperatorie. Arch. ital. Chir., 34, 225–410, 1933.

[8] DuNoüy, P. L.: Cicatrization of Wounds. Jour. Exper. Med., 24, 451–461, 1916.

[9] Garlock, J. H.: The Repair Processes in Wounds of Tendons and in Tendon Grafts. Annals of Surgery, 85, 92–103, 1927.

[10] Gratz, C. M.: Biomechanical Studies of Fibrous Tissues Applied to Fascial Surgery. Arch. Surg., 34, 461–495, 1937.

[11] Harvey, S. C.: Velocity of Growth of Fibroblasts in the Healing Wound. Arch. Surg., 18, 1227–1240, 1929.

[11a] Gaza, W. v., Gerlach, G., and Gissel, H.: Über den Stoffwechsel in Sehnenregeneration. Arch. f. klin. Chir., 170, 19–29, 1932.

[12] Harvey, S. C.: Reaction to Injury as Function of Growth (Lewis Linn McArthur Lecture). Proc. Inst. Med., Chicago, 10, 70–82, 1934.

[13] Harvey, S. C., and Howes, E. L.: The Treatment of Wounds. Yale Jour. Biol. and Med., 50, 79–83, 1928–1929.

[14] Hauck, G.: Über Sehnenverletzungen, Sehnenregeneration und Sehnennaht. Arch. f. klin. Chir., 128, 568–585, 1924.

[15] Hesse, F.: Experimentaluntersuchungen an Schnentransplantaten zur Frage der Heilungsvorgange bei Sehnennahte innerhalb synovialer Scheiden. Arch. f. klin. Chir., 169, 252–305, 1932.

[16] Hesse, F.: Die Behandlung der Sehnenverletzungen. Ergebn. der Chir. u. Orthop., 26, 174–264, 1933.

[17] Howes, E. L.: Strength of Wounds Sutured with Catgut and Silk. Surg., Gynec. and Obstet., 57, 309–317, 1933.

[18] Howes, E. L.: The Immediate Strength of the Sutured Wound. Surgery, 7, 24–31, 1940.

[19] Howes, E. L., and Harvey, S. C.: Strength of the Healing Wound in Relation to Holding Strength of Catgut Suture. New Eng. Jour. Med., 200, 1285–1291, 1929.

[20] Howes, E. L., and Harvey, S. C.: Recent Studies in Wound Healing. Yale Jour. Biol. and Med., 2, 285–294, 1930.

[21] Howes, E. L., and Harvey, S. C.: Clinical Significance of Experimental Studies in Wound Healing. ANNALS OF SURGERY, 102, 941–946, 1935.

[22] Howes, E. L., Harvey, S. C., and Hewitt, C.: The Rate of Fibroplasia and Differentiation in Healing of Cutaneous Wounds in Different Species of Animals. Arch. Surg., 38, 934-945, 1939.

[23] Howes, E. L., Sooy, J. W., and Harvey, S. C.: The Healing of Wounds as Determined by Their Tensile Strength. Trans. Sect. Surg., Gen. and Abd., A.M.A., 179–188, 1928.

[24] Howes, E. L., Sooy, J. W., and Harvey, S. C.: The Healing of Wounds as Determined by Their Tensile Strength. J.A.M.A., 92, 42–45, 1929.

[25] Hueck, H.: Über Sehnenregeneration innerhalb echten Sehnenscheiden. Arch. f. klin. Chir., 127, 137–164, 1923.

[26] Kleinschmidt, O.: Experimentelle Untersuchungen über den histologischen Umbau der frei transplantierten Fascia lata und Beweis dur die Lebensfähigkeit derselben unter Heranziehen der vitalen Färbung. Arch. f. klin. Chir., 104, 933–954, 1914.

[27] Levy, O.: Über den Einfluss von Zug auf die Bildung faserigen Bindegewbes. Arch. f. Entwicklungsmechanik der Organismen, 18, 184–246, 1904.

[28] Lumière, A.: The Healing of Wounds in Skin. Rev. de chir., 53, 656, 1917.

[29] Mason, M. L., and Shearon, C. A.: The Process of Tendon Repair. Arch. Surg., 25, 615–692, 1932.

[30] Meade, W. H., and Ochsner, A.: The Relative Value of Catgut, Silk, Linen and Cotton as Suture Materials. Surgery, 7, 485–514, 1940.

[31] Närvi, E. J.: Einiges zur Frage der Sehnenregeneration. Acta chir. Scandinav., 68, 267–277, 1931.

[32] Nicola, T.: Recurrent Dislocation of the Shoulder. Jour. Bone and Joint Surg., 16, 663–670, 1934.

[33] Rehn, E.: Zur frage der Transplantation, Regeneration und Ortseinsetzenden Metaplasie. Arch. f. klin. Chir., 112, 622–663, 1919.

[34] Rehn, E.: Zur Frage des Ersatzes grosser Sehnendefekte. Arch. f. klin. Chir., 114, 253–262, 1920.

[35] Roux, W.: Gesammelte Abhandlung über Entwicklungsmechanik der Organismus. Vol. 1, Funktionelle Anpassung. Leipzig, W. Engelmann, 1895.

[36] Salomon, A.: Untersuchungen über die Transplantation verschiedenartiger Gewebe in Sehnendefekte. Arch. f. klin. Chir., 114, 523–538, 1920.

[37] Salomon, A.: Über Sehnenersatz ohne muskel; ein Beitrag zur Lehre von den funktionellen Reiz. Arch. f. klin. Chir., 119, 608–642, 1922.

[38] Salomon, A.: Klinische und experimentelle Untersuchungen über Heilung von Sehnenverletzungen, besonders innerhalb der Sehnenscheiden. Arch. f. klin. Chir., 129, 397–430, 1924.

[39] Schwarz, E.: Über die anatomischen Vorgänge bei der Sehnenregeneration und dem plastischen Ersatz von Sehnendefekten durch Sehne, Fascie und Bindegewebe. Deutsch. Ztschr. f. Chir., 173, 301–385, 1922.

[40] Seggel, R.: Histologische Untersuchungen über die Heilung von Sehnenwunden und Sehnendefekten. Beitr. z. klin. Chir., 37, 342, 1903.

[41] Shambaugh, P.: The Silk Technique. Surgery, 7, 9–23, 1940.

[42] Spain, K. C., and Loeb, L.: Wound Healing. Jour. Exper. Med., 23, 107, 1926.

[43] Stewart, D.: An Experimental Study of the Return of Function after Tendon Section. Brit. Jour. Surg., 94, 388–396, 1936.

[44] Wolff, J.: Das Gesetz der Transformation der Knochen. Berlin, A. Hirschwald, 1892.

DISCUSSION.—DR. SAMUEL C. HARVEY (New Haven, Conn.): I am delighted to have the opportunity to discuss this most excellent paper that has been presented by Doctor Mason. It has the two aspects that are necessary, I think, to satisfy this audience whatever their interests may be. One is the theoretic aspect of wound healing and the other is the practical application of it. I should like to discuss both points briefly.

Theoretically, a wound heals by reversion to the same process of growth that takes place embryologically. In dealing with tensile strength we are dealing with that type of growth which is represented by the mesenchyme. It goes through the same phases of multiplication of cells, and the most important phase, of course, is the multiplication of fibroblasts, because that is the basic underlying cell for all the structures which later have to do with tensile strength or with the supporting strength as in bone.

The early phase of that is, I think, perfectly clear; that is the phase we speak of as the fibroblastic in the healing of wounds. There has always been some difficulty in following from that phase through to the growth of specific tissues. That, perhaps, is most outspoken in the matter of production of bone or the healing of fractures, and there arises there always the question, which is not perhaps a very important one but, theoretically, is of considerable interest, as to whether the new tissue, such as bone, is reproduced from specific bone cells or whether it is reproduced from fundamental, underlying fibroblastic cells by a process of differentiation. I, myself, am pretty well convinced the latter is the case—that again, as in the embryo, these cells, governed by a somewhat mystical concept, perhaps that of the organizer, which is specific for the particular situation in which the cell is involved, go on to differentiate into specific tissues as they did originally.

While that may seem to have not much bearing on this paper, I think it has a great deal. We have all been familiar for a long time with the so-called Wolff's law, which is supposed to represent the adaptation of tissues to specific functions because of the functional activity of the tissue itself. That has been a rather vague concept, difficult to prove but fairly apparent in experience, I think. Now more recently I think there is some indication as to how that takes place. Of course, we have known for a long time that the hammering of iron will convert it into a wrought iron which has a quite different tensile characteristic, or the tempering of iron will convert it into steel which again has a quite different characteristic. Very recently, of course, it has been found that with the production of synthetic textile materials, one of the steps in the process is the stretching out of the textile thread which produces —and that is definitely known—a molecular realignment which is along the line of the stress imposed upon the thread. Thas was rather graphically stated many years ago by Sir Arbuthnot Lane, as the alignment of tissues along the lines of force.

That has a direct application and is illustrated here, I think, in Doctor Mason's work, by the fact which he has clearly demonstrated that at the stage where the cells have reached a fairly mature situation but have not become realigned along the lines of force, the introduction of active functional pull upon the tissues accelerates such realignment, and in effect is an essential point in the eventual development of the tendon with the functions of a tendon.

Practically speaking, I think this is very important. He has laid down now, I think, for the first time, with a great deal of certainty, the period that immobilization should be carried out in tendon healing, which is ap-

proximately that of two weeks; that a period then ensues where the strengthening of the tendon will occur more rapidly if there is a limited mobilization, and after a week or so a period when freer mobilization and greater strength can be thrown upon the tendon, not only without danger but with very definite benefit.

I also should like to point out that he has contributed something to the old question of how one shall suture a tendon. It is obvious that the important thing in the suture of a tendon is not primarily the suture material but rather the way the suture material is applied. The holding power of the suture, as everywhere else, is the important thing, and the corollary of that is that one should use a suture of just sufficient size and strength to meet that holding power. There is no importance in using a suture larger than that because it will tear out of the tissues, and there is a great deal of importance in using the minimum suture material that is necessary because the less you use the less disturbance there will be in the healing process. Interpreted practically, to my mind that means the use of a fine, nonabsorbable material, such as silk, which will retain its strength well beyond the period when you wish to start active mobilization of the tendon.

DR. J. ALBERT KEY (St. Louis, Mo.): I have nothing but commendation for the work. They showed beautifully the strength of the tendon healing at various intervals. Clinically, however, the thing that worries me when I suture tendons is not pulling out or breaking so much as their sticking, and that is what happens to a lot of mine. They form adhesions. I know that this is beyond the scope of this paper. However, there must have been some observations. From the lantern slides it seems to me that the tendons which were immobilized did not form as many adhesions as those which were moved. The reason we have moved our tendons early was to prevent adhesions. I wonder if something will not be said along that line in closing the discussion.

DR. SUMMER L. KOCH (Chicago, Ill.): I am sure you will agree that Doctor Mason and Doctor Allen have made a definite contribution in helping us to know how to direct, wisely, the postoperative care of the patient who has had a division and repair of tendons. If we were to ask our youngest surgical intern the principles of treatment of a fracture he would tell us very promptly that they are: First, reduction; second, immobilization; and, third, immobilization in such a position that there is no tension on the fractured fragments; in other words, in a position of physiologic rest. That the same principles apply to the treatment of ruptured tendons, nerves, and soft tissues is sometimes forgotten. The experimental studies that have been reported help us to understand the importance of applying these surgical principles in the treatment of ruptured tendons, and how it can be accomplished.

There is a second analogy, as Doctor Harvey has pointed out, between healing tendon and healing bone, in that function plays so important a part in the process. John Hunter, many years ago, quoted the importance of function in the repair of fractured bones and in determining the direction of the lines of stress; Doctor Mason's experimental work has indicated clearly how and when functional activity can be used advantageously in securing sound healing with a minimum of reaction about the site of tendon callus. As Doctor Key said, our attention has been focused on preventing the "sticking" of sutured tendons. The principles that apply to the healing of every type of "fractured" tissue have often been ignored.

DR. MICHAEL L. MASON (Chicago, Ill., closing): I appreciate Doctor Harvey's and Doctor Koch's discussions more than I can say. I was glad to have Doctor Key bring up the question as to the time for starting motion following tendon repair. Motion is started early because the surgeon wishes to prevent adhesions; however, the opposite is the case. I had hoped to make it a little clearer in my talk that early motion and, certainly, early active, unrestricted motion leads to the production of marked reaction and adhesions. In those tendons which have been kept absolutely immobile, however, we have the most perfect type of healing.

It is my feeling that restricted motion can be safely started at the end of about two weeks; that is, toward the end of the period of fibroplasia. Restricted use, with a splint which prevents overstretching of the healing tendon, allows us to take advantage of the functional stimulus without the danger of leading to reaction and producing binding adhesions.

PARTIAL MYOTOMY IN THE TREATMENT OF DIVIDED FLEXOR TENDONS OF THE HAND

A REPORT OF TWO CASES

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ONE of the few surgical conditions characterized by a marked disparity between morbidity and mortality is that of the divided flexor tendon. The poor functional results attendant upon this injury, and the technical care necessary for its proper treatment, have been repeatedly described.[1, 2, 3, 4] It is the consensus of opinion that normal function is lost in a considerable percentage of cases. Furthermore, the degree of crippling of the hand increases, the more radial the site of trauma.

The clinical contrast between flexor and extensor tendon injuries, especially in the presence of infection, has been explained in terms of the tendon sheath. It has been assumed that the uniformly good results following repair of the extensor tendons are referable to the diffuse blood supply and the absence of fragile tendon sheaths, which form adhesions on slight provocation.

There is a third factor of real importance which has heretofore, in my opinion, not been adequately treated, *i.e.*, tension at the suture line.

It is the surgical custom to apply a molded plaster splint following the operative procedure. The position of hyperextension is used in extensor tendon cases, and acute flexion where flexor tendons have been repaired. While this rests the muscle and decreases its tension, it far from obviates the pull at the suture site. This fact is amply demonstrated by the very real tension invariably found as divided flexor tendon ends are being approximated with the patient under complete anesthesia. Despite the immobilizing plaster splint, normal muscle tone exerts its continuous dehiscent force on the suture line during the entire postoperative period. This is considerably more marked with flexors than with extensors because of the preponderant muscle bulk of the former, normally expressed by a flexed attitude of the relaxed hand.

Following an unsuccessful outcome in a flexor tendon case, in which the suture line parted on the seventh day due, quite evidently, to the extreme tension at the site of repair, the possibility of relieving the muscle strain by partial myotomy was first considered.

From the viewpoint of function, the tendon is merely a cord transmitting the muscle pull. The reaction of muscle to injury such as laceration differs markedly from that of tendon. The former has a rich blood supply, healing promptly with minimal loss of strength. The highly contracted scar in a muscle belly does not seem to interfere with its subsequent function, a demon-

Submitted for publication September 29, 1939.

strable fact in any extensive lacerated wound of the extremities. This is also characteristic of the smooth muscle sphincters, which heal rapidly following complete division.

The flexor muscles of the forearm are of the unipennate type with the tendon prolonged throughout the length of the muscle. Hence, division of the muscle which includes the tendon prolongation results in a loss of contractile power, the degree of which bears a direct relationship to the site of division. Since this point in the two cases herein described was selected at the junction of the distal third with the proximal two-thirds of the muscle, it is apparent that only those fascicles in the distal third were able to exert any pull through the tendon. As the muscle wound healed, uniting the divided portions of the muscle and the divided ends of the tendon prolongation, the muscle power returned so that, as in the first case, the patient regained more than two-thirds of the muscle strength within nine weeks of the time of operation. The myotomy wound evidently healed *pari passu* with the repaired tendon so that, during the second month of convalescence, the muscle power rapidly returned at a time when the tendon was once again able to bear the full stress.

There are two additional advantages to this procedure: First, following the myotomy, the interval between the divided tendon ends is diminished by an actual transposition of the tendon due to the gaping of the muscle wound. This amounts to at least one-half inch, serving to allow approximation of the tendon ends in addition to the main purpose of relieving the tension on them This may be of use in secondary tendon surgery as a substitute procedure for short, free tendon grafts. Second, following the procedure it is possible to place the hand and finger in a neutral or slightly flexed position. This is of real advantage during the period of convalescence since it is far easier to regain normal function in a finger so placed than in one that has been coiled up in the most acute flexion for a month postoperatively.

CASE REPORTS

Case 1.—Hosp. No. 33783; J. P., white, male, age 41, accountant, was admitted, April 18, 1939, shortly after a porcelain faucet handle crumbled in his right hand. Examination revealed an irregular transverse laceration of the center of the palm with complete loss of flexion of the interphalangeal joints of the index finger. There was also anesthesia of the radial half of the palm and of the opposing surfaces of the index and middle fingers. Operation was immediately performed, complete hemostasis being obtained by the use of a blood pressure cuff applied to the arm. The sublimis and profundus tendons to the right index finger were found to be completely divided. By extension of the wound it was possible to seize the divided profundus tendon ends. They were approximated under considerable tension. For that reason, with clean instruments, an incision was made in the lower third of the forearm through which the corresponding pofundus muscle belly was identified and isolated. At the junction of the distal and middle thirds of the muscle a short transverse incision was made resulting in almost complete relief of the tension at the site of injury so that the divided tendon ends, after the clamps holding them were cut away, were easily approximated with fine Pagenstecher linen thread using the Connell technic. The hand and finger were placed in 10° flexion and a dorsal plaster splint was maintained postoperatively for 25 days (Fig. 1). During this time guided active motion was allowed each day except on the tenth day

when, due apparently to edema, no motion was possible. The wounds remained clean. From the fourth week on, radiant heat, massage and active motion were instituted The patient returned to work at the end of the fifth week. By the end of the seventh week there was a normal range of flexion and extension at the interphalangeal joints, with slight restriction at the metacarpophalangeal joints. By the end of the eighth week he could touch the tip of the finger to the palm. By the twelfth week the finger could be actively coiled up and moved in all directions with agility equal to that of the normal side (Fig. 2). As was expected, there was definite improvement in sensation, the prognosis remaining good for this aspect of the case. The patient was discharged with a normally functioning finger in the fifteenth week.

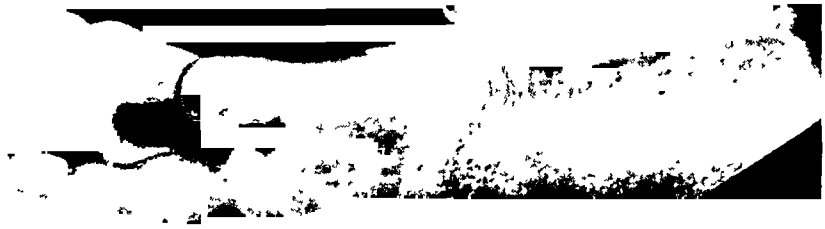


FIG 1.—Case 1 The relaxed hand three weeks after injury. The flaccid index finger is lying in a neutral position with evident diminution of flexor tone.



FIG. 2.—Case 1. The relaxed hand 11 weeks after injury. The increased flexor tone of the index finger can be readily seen The flexion of the other fingers is slightly increased, due to use of the hand

Return of muscle power was tested by holding the forearm and finger rigid against a wooden splint and flexing the distal interphalangeal joint over the edge of the splint. At the end of the sixth week a four-pound weight could be easily moved over a pulley by the terminal phalanx throughout the full arc of flexion. By the twelfth week an eight-pound weight was easily so moved; by the fourteenth week, nine pounds. Control for the terminal phalanx of the normal index finger was 11 lbs. flexion.

Case 2.—Hosp no. 34090: P. C., white, male, age 44, office-worker, was admitted, June 13, 1939, shortly after having broken a water bottle in his left hand. He suffered jagged lacerations of the ring and little fingers. There was no loss of sensation but there was complete loss of flexion of the interphalangeal joints of the little finger. At operation, only the divided profundus tendon ends were seized and brought together at the middle phalanx. As is characteristic of this finger, there was a good deal of tension. For this reason, an incision was made in the forearm just lateral to the ulnar vessels and nerves.

The flexor profundus digiti quinti muscle belly was readily identified. About half of the thickness of the muscle was divided, resulting in a definite diminution of tension with much easier approximation of the divided tendon ends. The myotomy wound gaped more than half an inch. The tendon ends were repaired with a fine linen, Connell suture. A posterior molded plaster splint was applied with the hand and finger in slight flexion. This was maintained for four weeks. During the second and third weeks there was a loss of the undercut skin overlying the suture site. The mucopurulent discharge from this point was evidently due to sloughing skin and not to a real infection. During the fifth week, there were a few degrees of flexion of the terminal phalanx and about 10° of the proximal interphalangeal joints. By the end of the sixth week the wound was healed. Physiotherapy has been administered since then.

SUMMARY.—One of the adverse factors responsible for the poor results attendant upon division of the flexor tendon is that of tension at the site of repair.

A simple method of myotomy consisting of simultaneous division of the tendon prolongation at a selected site in the forearm is proposed as a corrective procedure.

Evidence is offered that a muscle wound heals *pari passu* with the tendon, leaving no defect.

REFERENCES

[1] Koch, S. L., and Mason, N. L.: Division of the Nerves and Tendons of the Hand. Surg., Gynec., and Obstet., 56, 1, January, 1933.

[2] Bunnell, S.: Reconstructive Surgery of the Hand. Surg., Gynec., and Obstet., 39, 259, September, 1924.

[3] Garlock, J. H.: The Repair Processes in Wounds of Tendons and in Tendon Grafts. ANNALS OF SURGERY, 85, 92, January, 1927.

[4] Mayer, L.: The Physiological Method of Tendon Transplantation. Surg., Gynec., and Obstet., 33, 528, November, 1921.

DISLOCATION OF THE FIRST CERVICAL VERTEBRA*

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Classification.—Dislocation of the first cervical vertebra is the partial or complete loss of contact of the inferior articulating surfaces of one or both lateral masses of the axis with the corresponding superior articular facets of the epistropheus. The dislocation may be anterior, right or left rotary, posterior and right or left lateral. A fracture of the odontoid generally accompanies the latter two types.

Etiology.—The dislocation may result from trauma, infection, paralysis, or congenital defect. Automobile accidents, falls on stairs, falls from bed, sudden turns of the head, and postoperative overcorrection of torticollis are some associated causes. Traumatic dislocations are frequently associated with a fractured odontoid. The tip of the odontoid is securely attached to the basilar process of the occiput by the alar and apical ligaments. A force directed from the head is transmitted through these ligaments against the anterior arc of the atlas or the transverse ligaments as a fulcrum to be levered at the base of the odontoid. If the transverse ligament withstands the strain, the base of the odontoid is fractured.

Following infection, the ligaments supporting the atlas on the epistropheus become relaxed, permitting a spontaneous dislocation. The relaxation of ligamentous support may be due to bone destruction, bone decalcification or joint involvement. The vertebral bone may be destroyed by pyogenic, tuberculous or syphilitic osteomyelitis. Bone decalcification and joint involvement follow an adjacent cervical infection as sinusitis, pharyngitis, tonsillitis, mastoiditis, adenitis or dental abscess. The otolaryngologic literature classifies such a spontaneous dislocation following cervical infection as "Grisel's disease." Leriche and Poligard[5] explain the decalcification on the basis of calcium absorption from the hyperemia induced by the infection. Watson Jones[4] supports this in reporting a boy of nine years with a mastoiditis and cervical adenitis with a dislocation in which the roentgenograms revealed complete decalcification of the anterior arch of the atlas. Following reduction, and as the infection subsided, recalcification occurred. The joint involvement with distention of the capsule and stretching of supporting ligaments, Wittek and Jacobs[12] claim, is from the regional hyperemia. Coutts[2] believes the axoid-epistropheal joints are involved by direct extension of the infection through the lymphatics. The detachment of ligaments accompanying

* Read before the American Surgical Association, St. Louis, Mo., May 1, 2, 3, 1940.

decalcification or stretching of the ligaments from joint involvement results in articular relaxation that permits dislocation. This may be gradual, from the position of comfort assumed by the head during the infection, or sudden, from an attempt to change the position of the head. The former is illustrated by Grieg[3] in citing a case reported by Benjamin Bell, 100 years ago, in which a dislocation of the atlas was recognized in a subject with a chronic pharyngeal ulcer. Sudden dislocation is noted by Watson Jones in a case with tuberculous cervical adenitis with sinuses. As the nurse attempted to change the position of the head to facilitate dressing, the subject died. The autopsy revealed that the first cervical vertebra had been dislocated with impingement of the spinal cord.

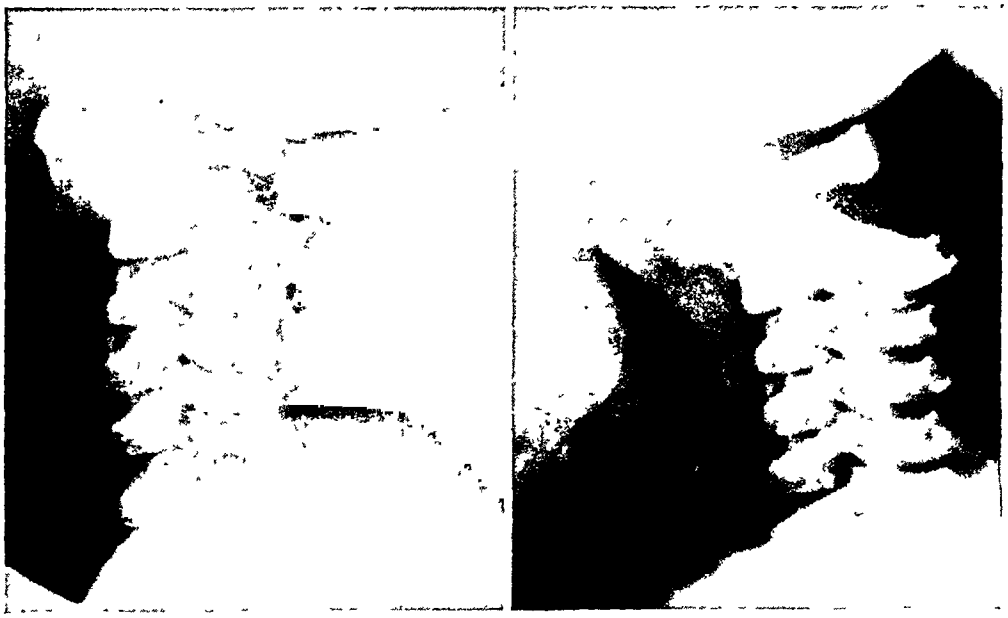
Paralytic dislocations from muscle imbalance have been accredited by Coutts as occurring in the subacute stage of poliomyelitis.

Congenital absence of the odontoid was reported by Roberts[10] as a cause for dislocation of the first cervical vertebra. This subject was a man, age 20, who was pivoting on his head in a gymnasium when something snapped at the base of his skull. He had sudden severe pain in his neck. Roentgenograms showed a forward dislocation of the first cervical vertebra and an absence of odontoid. The dislocation was reduced by head traction. Operative fixation was advised but refused. A leather collar was applied. The subject had no recurrences for one year but subsequently could not be located.

Anatomy.—The axoid-epistropheal relation is dependent upon three common articulating surfaces. The axis is constructed of two lateral masses joined anteriorly by a narrow mass of bone, the arcus anterior, and posteriorly by a similar but larger mass, the arcus posterior. The lateral masses articulate superiorly with the condyles of the occiput and inferiorly with the superior articulating facets of the epistropheus. The superior articulations are slightly concave to permit a rocking action. The inferior are almost flat to permit a gliding rotary action. Both superior and inferior articulations are in the horizontal plane. The inferior facets are, therefore, particularly dependent upon ligaments for support. The arcus anterior articulates with the odontoid process or dens of the second vertebra. The odontoid is a superior projection of the body of the second cervical vertebra. It has a flattened surface covered with cartilage both anteriorly and posteriorly. Across its posterior surface is stretched the transverse ligament from the two lateral masses of the atlas. From the tip of the odontoid extend two alar ligaments and an apical ligament to the occiput of the skull. These ligaments are covered by the tectoria membrane which extends downward from the basilar process of the occipital bone over the posterior surfaces of the vertebral bodies. The tectoria membrane, in turn, is covered by the posterior longitudinal ligament which has similar attachments. Anteriorly, the atlas is supported by the anterior longitudinal ligament which extends from the inferior surface of the basilar process of the occiput attaching along the anterior surface of the vertebral bodies. The posterior arch is bound to the posterior margins of

the foramen magnum by the atlanto-occipital membrane and the arch of the second cervical vertebra by the ligamentum flavum.

Diagnosis.—Coutts gives an excellent description of the interpretation of clinical and roentgenologic diagnosis of axoid-epistropheal dislocation. The authors agree that the diagnosis is indicated by few constant symptoms and signs, and that the verification of the diagnosis is determined by the roentgenogram. The head is held in a torticollis position. The chin is frequently held tightly against the larynx. It is often difficult to open the mouth. Dysphagia and voice change may be observed. Pain is in the occipital and mastoid areas due to pain reference in the distribution of the second cervical nerve. These areas are tender to touch. Motion, particularly extension, increases the pain.



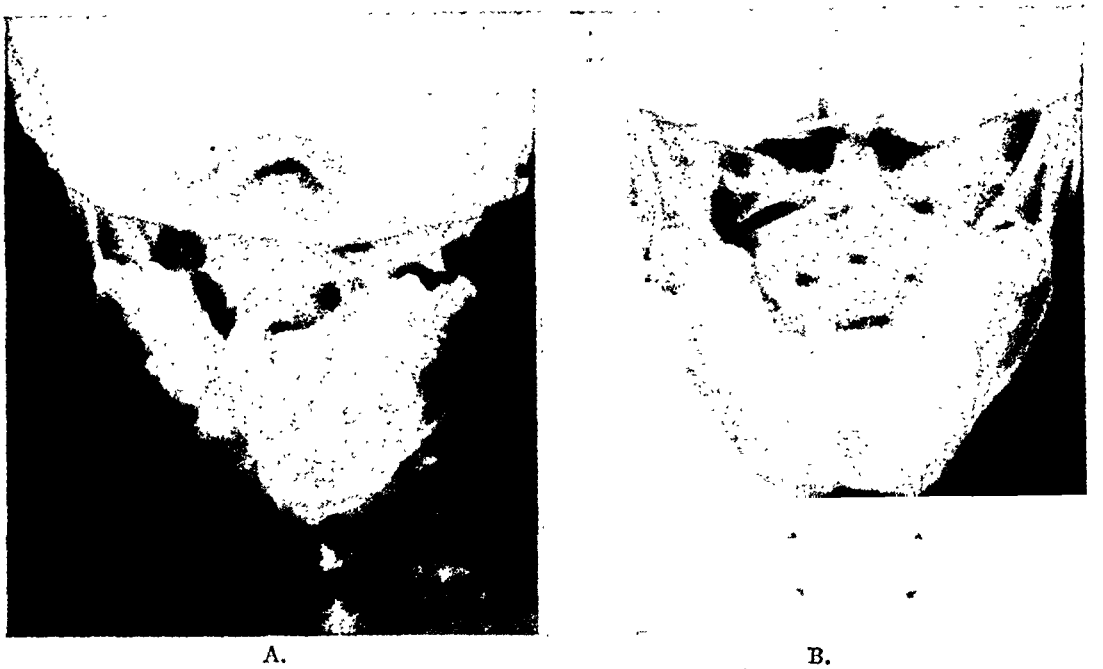
A. B.

FIG. 1.—Case 6: Lateral view of cervical spine showing anterior dislocation of the first cervical vertebra. A. Shows the spine is in maximum extension. B. Shows the spine is in maximum flexion. These comparative films show the extent to which deformity is exaggerated in the flexed position. This is of value in the follow-up examination to clarify the question of luxation, after the plaster case immobilization, applied after reduction has been removed.

The subject rises, supporting the chin in his hands. On attempted cervical motion, grating of the neck is experienced. This may be audible to the examiner. The head can be laterally flexed but slightly from the side to which it is tilted. The chin cannot be rotated past midline in attempting to correct the rotation deformity so that the subject must turn his entire body to see over the opposite shoulder. Posteriorly, the paraspinal muscles are prominent on the side to which the chin rotates. This prominence is accentuated if any attempt is made to straighten the head. If the mouth can be opened, the pharynx will bulge on the side to which the head is tilted. Paralysis is relatively infrequent in those cases surviving the force producing the dislocation. When present, however, it is more common in the arms. Sensation may be retained as the pyramidal decussation lies directly behind the odontoid. Death may be im-

mediate if the medulla is compressed, but the diameter of the foramen magnum permits considerable displacement without cord compression.

The roentgenologic diagnosis is dependent upon anteroposterior and lateral views. If the lateral views are taken in maximum extension and maximum flexion of the cervical spine, the dislocation is found exaggerated by flexion (Fig. 1 A and B). There is a lordosis of the lower cervical spine. The anterior arch of the atlas appears more than 2 Mm. anterior to the odontoid, unless the latter is fractured. The posterior arch of the atlas appears broader in unilateral dislocations as it is tilted. If lines are drawn through the inferior



A. B.

FIG. 2.—Case 5: A. Shows a left rotary dislocation of the first cervical vertebra. A typical torticollis position of the head is shown. The overlap of the lateral masses of the atlas and their asymmetrical relationship to the odontoid is visualized. B. The same, following reduction.

surface of the first cervical and the base of spine of the second they will be found to converge rather than parallel one another. The odontoid, if fractured, fails to appear as a continuation of the body of the second cervical.

The anteroposterior view is difficult to obtain as the head frequently cannot be extended nor the mouth opened (Fig. 2 A and B). The second cervical spine appears as an inverted V and is deviated to the side to which the chin is rotated. The successive cervical spinous processes gradually return to midline. Accompanying the rotation deformity, a widening of one and a narrowing of the other lateral facet between the first and second vertebrae or loss of space between both facets is observed. When the odontoid is fractured it may appear nearer to one lateral mass than the other.

The vertex-mental view is advocated by Pendergrass and Chamberlain[9] as an aid in the roentgenologic diagnosis of dislocation of the first cervical vertebra. They state that this is taken diagrammatically opposite from the view described by Hirtz (Fig. 3). The anterior arch of the atlas projects away from the odontoid process. One lateral mass of the atlas is more closely ap-

proximated to the odontoid. This lateral mass fails to superimpose with the superior facets of the epistropheus. A transverse process and the spinous process of the epistropheus both project from either half of the posterior arch of the atlas.

Differential Diagnosis.—The diagnosis of dislocation of the first cervical vertebra is readily confused in the absence of a traumatic injury. Brookes[1] cites that children are frequently irritable during the prodromal stage of an infection and may be subjected to some form of punishment as a shaking or spanking which, though unrecognized at the time, exerts sufficient trauma to initiate the dislocation. Padula and Tracey[8] recently reported such a case in a four and one-half-months-old infant, who developed respiratory difficulty



FIG 3.—Case 5. A vertex mental view of a left rotary dislocation of the atlas showing a retouched roentgenogram, and corresponding dislocation in an anatomic specimen

following a shaking by an irate father because he was annoyed by its cries. Generally the torticollis deformity is not recognized until after the illness. Woltman and Meyerding[13] suggested that the absence of neurologic findings could account for mistaken diagnoses of pharyngeal abscess and cervical arthritis; while less frequently the delayed and gradual onset of neurologic symptoms would be confused with cerebellar tumor, syringomelia, bulbar palsy and myasthenia gravis.

Treatment.—The dislocation should be reduced as soon as possible after recognition. A method has been employed[7] by which the weight of the dependent head results in spontaneous reduction. This method is not adaptable for posterior dislocations of the first cervical vertebra which are accompanied with a fractured odontoid, as, theoretically, the deformity would be increased and cord compression could result. Caution is indicated in its immediate application after traumatic dislocation in which edema of the cord would cause a further paralysis. In treating fracture dislocations in other regions

of the cervical spine by this method it was learned that children tolerated it better than adults. An uncomfortable complication in adults was edema of the scalp.

Method.—Two or three short mattresses are placed on the fracture bed (Fig. 4). The head is gradually, for the first 24 to 48 hours, extended further over the end of the top mattress until the subject's shoulders rest on the edge of the mattress. The head then hangs free for another 24 to 48 hours. The subject is held in position by applying Buck's extension to the legs and raising the head of the bed. When rotation and lateral flexion of the head are free and equal in both directions, reduction has been accomplished. The reduction is checked roentgenologically simply by transferring mattresses and child with head hanging over the end onto a stretcher and transporting him to the

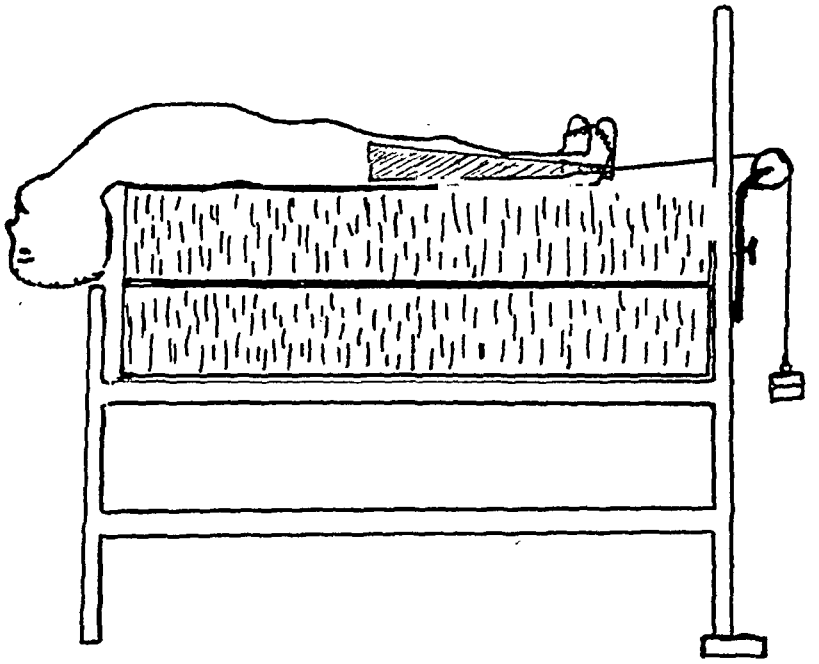


FIG. 4.—Diagrammatic representation of the position of the patient in bed, which is employed in the treatment of a dislocation of the first cervical vertebra.

roentgenologic department, if no portable apparatus is available. Roentgenograms are taken without disturbing the position of the head by holding a casette on the side of the neck for the lateral view and repeated with the casette in back of the head for the anteroposterior view.

Reduction is maintained by a plaster bandage from head to pelvis. It is necessary to have the chin and forehead included so as to prevent flexion of the head, which would cause redislocation. The plaster encasement is extended to the pelvis so that its weight is borne more comfortably by the patient. The method of applying the plaster bandage is to transfer the patient from the mattress without supporting the head, so that his back rests on the canvas sling of an Abbott frame and the head hangs dependent. A body jacket is then applied. As this dries, a table of suitable height is pushed beneath the patient. The canvas sling is released so that the table supports the patient's trunk. The Abbott frame and sling of canvas are then removed.

A four-inch muslin bandage, with a longitudinal slit in its midportion which will permit it to be slipped over the patient's head to run beneath the chin and occiput, is arranged so that the ends may be tied behind the operator's back. In this way the operator can exert traction and control the amount of extension of the neck. The extension which occurs at the occipito-axoid joint is not necessary, and not desired, as it will fix the subject's head looking heavenward. The head encasement is then applied over the traction bandage, which can be withdrawn after the head and body parts of the plaster case are joined together.

The fractures of the odontoid were held for 12 weeks in plaster, and then a Thomas collar worn for eight weeks.

The dislocations were held for 16 weeks in plaster, and four to eight weeks with a Thomas collar. The Thomas collar was necessary in order to permit rehabilitation of the cervical muscles. The atrophied muscles readily fatigued, thus permitting strain on the ligamentous structures. The strain caused pain and could produce another dislocation. The motion of the cervical spine permitted by the Thomas collar allowed the musculature to develop without the hazard of fatigue and ligament strain.

CASE REPORTS

Case 1.—T. S., male, age 7½, on March 3, 1935, was in a tussle, in which another boy had him in a head-lock. He had pain in the occipital region. The head was held tilted to left and rotated to right. He was admitted to the Graduate Hospital the same day. Roentgenologic examination revealed a fracture of the odontoid base with posterior displacement of one-quarter the breadth of the base. Traction was applied to the head by means of a Sayre collar and a four pound weight. The neck was held in slight extension by means of a partially inflated air-ring beneath the shoulders. After reduction was verified roentgenologically, a plaster encasement was applied from head to pelvis. This was worn three months, after which a celluloid Thomas collar was applied and worn for three months. Roentgenograms taken one year later (March 23, 1936) showed a very slight anterior position of the odontoid and obliteration of the fracture line. There was full motion in the cervical spine, and no deviation of the head.

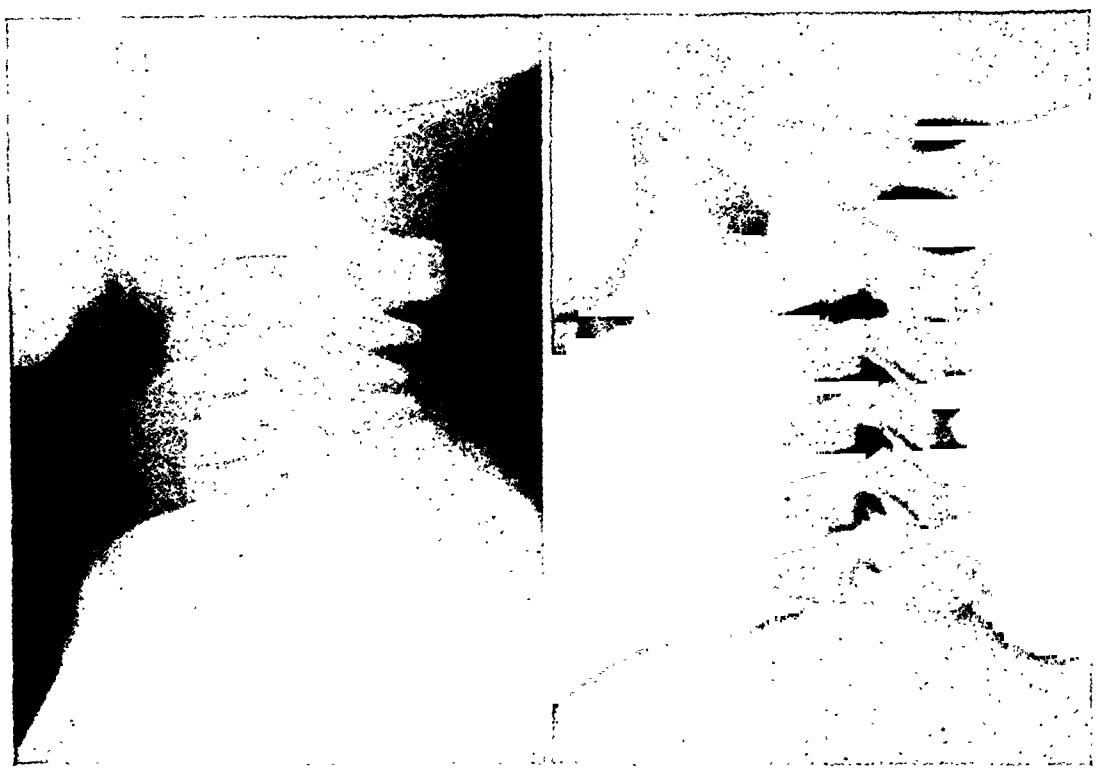
Case 2.—M. D., colored, female, age 3½, had her neck stepped on by an adult, 48 hours before admission to the Children's Hospital, August 25, 1936. She complained of pain in neck and would not turn her head. The head was tilted to the left and the chin was rotated to the right. Roentgenograms showed a fracture at the base of the odontoid, with anterior displacement (Fig. 5 A and B). After 48 hours of dependent head traction, a plaster encasement was applied from the head to the pelvis. This was worn three months. A Thomas collar was then worn for two months. At examination May 24, 1937, there was but slight deviation of the head and full range of cervical spine motion. Roentgenograms showed the fracture healed and the dislocation reduced.

Case 3.—J. D., male, age 60, had delirium tremens and fell downstairs May 30, 1935, sustaining a fracture of the odontoid, with anterior displacement of the first cervical vertebra, and a fracture of the right humerus. He was admitted the same day to the Philadelphia General Hospital. He had no neurologic involvement. Due to mental confusion, it was necessary to feed him through a nasal tube. He developed a decubitus ulcer on his chin from the Sayre collar traction. The dependent weight of the head was tried. In 24 hours, reduction had been accomplished. A plaster encasement was applied from head to pelvis. The patient tore off the encasement 24 hours later. He was transferred to the psychiatric ward. The reduction could not be maintained with

Sayre traction. No symptoms referable to cord pressure developed up until his death six weeks later from pneumonia.

Case 4.—W. S., colored, male, age ten, was admitted to the Children's Hospital November 16, 1936. Three weeks before admission, during illness from acute tonsillitis, he awakened one morning with pain in mastoid region and a stiff neck, which forced him to hold his head tilted to right and the chin rotated to left.

Roentgenologic examination revealed a forward dislocation of the right lateral mass of the first cervical vertebra. He was treated with his head hanging dependent as described. After four days, the roentgenogram verified the reduction and a plaster jacket from head to pelvis was applied. After four months (March 25, 1937) the encasement was removed and a Thomas collar applied, which was worn for one month. On examination March 14, 1938, there was a questionable tilt of head to the right.



A. B.

FIG. 5.—Case 2: A. A fracture through the base of the odontoid, with anterior dislocation. B. The same, three months after reduction.

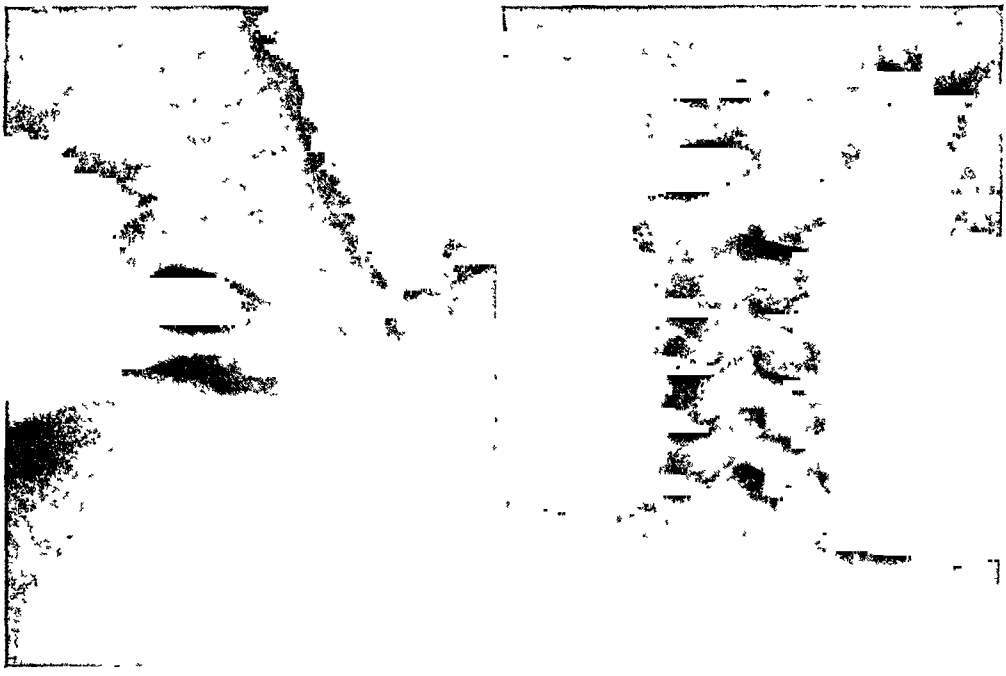
Lateral flexion of the cervical spine was 20° less to the left than to the right. Other motions were unimpaired.

Case 5.—B. T., female, age eight, had a prolonged history of upper respiratory infection and pharyngitis. She had had cervical adenitis for five weeks. For two weeks prior to admission to the Mary Drexel Home May 9, 1938, her head had been turned with the chin on the right shoulder and head tilted anteriorly. Examination revealed the head held in 70° rotation to the right and 30° flexion to the left. Rotation of the head to the left could not bring the chin within 30° of the midline. Rotation of the head to the right was 100°. Flexion to left was 45°. Flexion to the right was zero. No other physical signs were present. Roentgenograms showed a rotary displacement of the atlas to the right, with a luxation of the occipital condyles to the right on the lateral masses (Figs. 2 and 3). With the head hanging dependent the dislocation reduced in 48 hours. The usual type of plaster encasement was applied and worn for three months, after which a leather-reenforced collar was worn for two months. At

examination December 2, 1938, the roentgenogram showed reduction maintained. The chin was, clinically, slightly to right of the midline but the cervical motions were equal.

Case 6.—D. S., female, age three, was admitted to the Children's Hospital June 2, 1936. She had had measles six weeks previously which was followed by a cervical adenitis and bilateral otitis media. The neck had been held stiffly with the head turned to the right for a week. There was anterior displacement of both lateral masses (Fig. 1). Head traction by means of a Sayre collar was tried in this case for four weeks without success. Reduction occurred in 24 hours when the head was allowed to hang dependent (Fig. 6A and B). A plaster encasement was applied from head to pelvis. This was changed at the end of three months and removed in four months. A Thomas collar was worn six weeks.

January 4, 1937, two weeks after removal of Thomas collar, dislocation recurred.



A. B.

FIG. 6.—Case 6. A. Showing reduction with head hanging dependent. Note the amount of distraction between the occiput and first cervical vertebra, denoting ligamentous relaxation. Lateral films prior to reduction are shown in Figure 1. B. Following surgical fixation, in which the laminae were wired together.

Reduction was accomplished with the head dependent and a plaster encasement was applied on the third day. At end of five months the encasement was removed and a Thomas collar applied. One week after removal of Thomas collar the second time, a recurrence of dislocation was observed.

Operation.—July 29, 1937: An open reduction of the first and second cervical dislocation was performed through a posterior midline incision. The head of patient was held in position by means of a plaster bed. Traction on the posterior arch of the first cervical vertebra was made by a towel clip in order to approximate it to the arch of the second cervical vertebra. The arches were lashed together, as advocated by Osgood and Mixter,[6] with a strip of fascia lata from the thigh. A jacket was worn four weeks and a Thomas collar applied. The dislocation again recurred. *Second Operation.*—August 2, 1937, the fascial suture was found to have pulled free from its silk sutures. It was then observed that a mistake had been made in not knotting the fascia to itself and securing the knot with silk. This time, two wire sutures were passed around the posterior arches of the first and second cervical vertebrae, and an attempt was made to

obtain bony fusion between them by removing the ligaments and cartilaginous covering and overlapping pedicle grafts.

Four months later the plaster encasement was removed. The position had been maintained and a Thomas collar was applied and worn three additional months.

At examination June 1, 1939, 21 months after the second operation, the head was held with a slight tilt to the left. Extension 30°. Flexion 45°. Rotation 25° left, 45° right. Lateral flexion, bilateral, 45°. There were no neurologic findings. Roentgenograms showed no forward luxation with flexion, according to comparative lateral roentgenograms with the cervical spine in maximum extension and flexion.

TABLE I

SUMMARY OF SIX CASES OF DISLOCATION OF THE FIRST CERVICAL VERTEBRA

Case	Initials	Age	Etiology	Dislocation	Complication	Result
1.	T. S.	7½	Trauma	Posterior	Fracture odontoid	Reduced
2.	M. D.	3½	Trauma	Anterior	Fracture odontoid	Reduced
3.	J. D.	60	Trauma	Anterior	Fracture odontoid; fracture right humerus; delirium tremens	Death from pneumonia
4.	W. S.	10	Spontaneous. Ac. tonsillitis	Right. Rotatory	None	Reduced
5.	B. T.	8	Spontaneous. Cervical adenitis	Left. Rotatory	None	Reduced
6.	D. S.	3	Spontaneous. Measles. Cerv. adenitis. Bilateral otitis media	Anterior	Three recurrences. Two open fixations	Reduced

Discussion.—In the six cases reported, the traumatic and spontaneous dislocations were equally divided (Table I). The traumatic dislocations were associated with a fractured odontoid. One of this group had a posterior dislocation. There were three anterior dislocations, one spontaneous and two with a fractured odontoid. The two remaining spontaneous dislocations were rotatory. The spontaneous dislocations had been preceded by a regional cervical infection and not by an involvement of the vertebra. No neurologic symptoms were encountered in this group.

With the exception of the posterior dislocation, all reduced spontaneously by permitting the head to hang dependent.

The reductions were maintained by a plaster of paris bandage from forehead including the pelvis. The fractured odontoids were held three months. The spontaneous dislocations were immobilized for four months. After the removal of the plaster bandage, a Thomas collar was used on an average of six weeks, until the cervical muscles were rehabilitated. At the end of six months, if lateral roentgenograms, taken with the head in maximum flexion, showed no luxation of the axis, the dislocation was considered reduced.

There were two complications in the series. The one, Case 3, a male, age 60, with delirium tremens in which fixation was abandoned, developed pneumonia six weeks subsequently and died. The other, Case 6, was a child who had three recurrences without attributable trauma; two, after two complete six-month fixation periods; the third, four weeks subsequent to operative fixation, in which fascia lata was used to fasten the laminae of the first and second cervical vertebrae together (Fig. 7). An error in the operative technic was found responsible for the third recurrence of the dislocation. The ends of the fascia lata suture were not knotted before being sewn together with silk, so that they pulled free.

SUMMARY.—Dislocations of the first cervical vertebra were a result of trauma, infection (spontaneous), muscle paralysis or congenital defect. The ligaments supporting the axis and epistropheus normally prevented luxation. A force, on the other hand, levered by the ligaments, resulted in a fracture of the odontoid. Six cases of dislocation of the first cervical vertebra, ranging from three to 60 years of age, are reported after observation from one to four years. Three cases had a traumatic history and were associated with a fractured odontoid. Three were spontaneous dislocations following associated

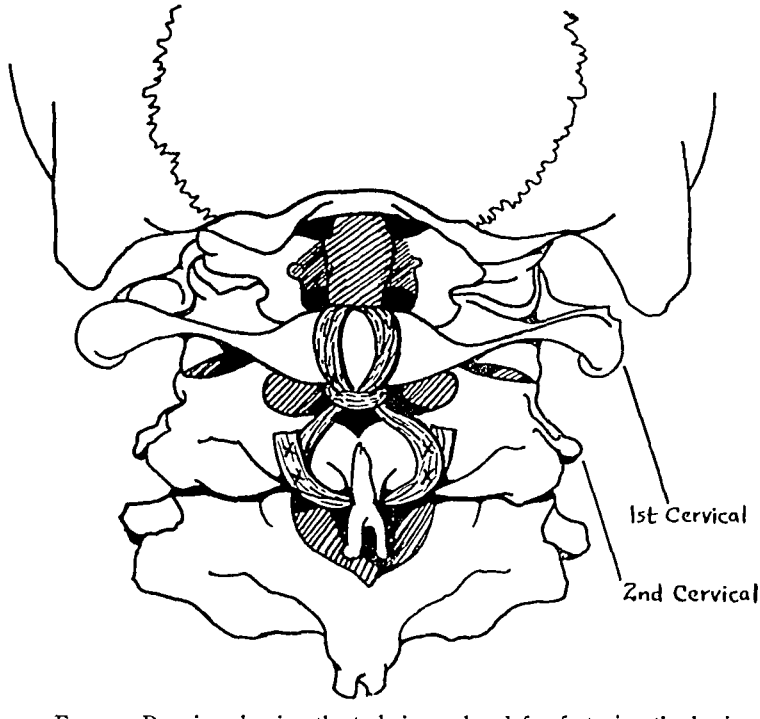


FIG. 7.—Drawing showing the technic employed for fastening the laminae of the first and second cervical vertebrae with fascia lata. (Modification of the method advocated by Mixter and Osgood.[6])

infections in the cervical region. One case with a fractured odontoid had a posterior dislocation. Two had anterior dislocations. One spontaneous dislocation had an anterior dislocation, two spontaneous dislocations had rotatory displacement, one to the left and the other to the right. No cases had any neurologic disturbance from the dislocation. All except the posterior dislocation were reduced spontaneously with the head hanging dependent. Reductions were maintained by a plaster of paris bandage, including forehead and pelvis, for three months if associated with a fractured odontoid, and four months if spontaneous. A Thomas collar was used for six additional weeks. There were two complications. One case, with delirium tremens, was uncooperative, reduction could not be maintained by plaster fixation and death resulted from pneumonia. The second case had three recurrences in 15 months, each time after mechanical fixation was discontinued. This patient had two surgical attempts made to maintain reduction. The second surgical

procedure has remained successful for 21 months, with no external fixation for 17 months.

CONCLUSIONS

(1) Dislocation of the first cervical vertebra is commonly caused by trauma or infection.

(2) Traumatic dislocations are frequently associated with a fractured odontoid.

(3) The infection is rarely in the vertebra but in the surrounding cervical tissues. The dislocation in such instances is spontaneous.

(4) Neurologic complications are infrequent. Those reported in the literature are immediate or delayed, and gradual in onset.

(5) Dislocations of the first cervical vertebra can be safely and easily reduced spontaneously with the head hanging dependent, except posterior dislocations or in the presence of neurologic complications.

(6) A recurrence of a dislocation after described care requires operative fixation.

REFERENCES

[1] Brookes, T. P.: Dislocations of the Cervical Spine. J.A.M.A., 104, No. 11, 902, March 16, 1935.

[2] Coutts, M. B.: Atlanto-Epistropheal Subluxation. Arch. Surg., 29, 297, August, 1934.

[3] Grieg, D. M.: Fracture and Dislocations of the Odontoid. Clin. Obs. Surg. Path. of Bone. Edinburgh, Oliver & Boyd, 1931.

[4] Jones, R. Watson: Spontaneous Hyperemic Dislocation of Atlas. Proc. Roy. Soc. Med., 25, 586, 1932.

[5] Leriche, R., and Poligard, A.: Physiology of Bone. Translation, S. Moore and J. A. Key. C. V. Mosby Co., St. Louis, 1928.

[6] Mixter, S. J., and Osgood, R. B.: Traumatic Lesion of the Atlas and Axis. ANNALS OF SURGERY, 51, 193, 1910.

[7] Nicholson, J. T.: Spontaneous Reduction of Cervical Dislocation. Read before A.M.A., New York, June, 1940.

[8] Padula, R. D., and Tracey, E. J.: Fracture Dislocation of Axis and Atlas in an Infant. J.A.M.A., 112, No. 12, 1149, March 25, 1939.

[9] Pendergrass, Eugene P., and Chamberlain, George W.: Personal communication.

[10] Roberts, S. M.: Congenital Absence of the Odontoid Process Resulting in Dislocation of the Atlas. Jour. Bone and Joint Surg., 12, 988, October, 1933.

[11] Spalteholz, Werner: Hand Atlas of Human Anatomy, VI. J. B. Lippincott Co., Phila., Pa.

[12] Wittek and Jacobs (referred to by Frank, I.): Atlanto-Axial Subluxation of Atlas. Ann. Otol. Rhin. and Laryng., 45, 405, June, 1936.

[13] Woltman, H. W., and Meyerding, H. W.: Spontaneous Hyperemic Dislocation of the Atlo-Axoid—Report of Case. S. Clin. N. Amer., 14, 581, June, 1934.

BRIEF COMMUNICATIONS AND CASE REPORTS

A MECHANICAL AID FOR VENIPUNCTURE

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ATLANTA, GA.

THIS INSTRUMENT was designed to facilitate venipuncture where large-sized needles (No. 13 to 16 gauge) are employed in transfusions. The underlying principle has been evolved after an experience of approximately 1,000,000 venipunctures, over 60,000 of which have been performed by the author during the past two years.

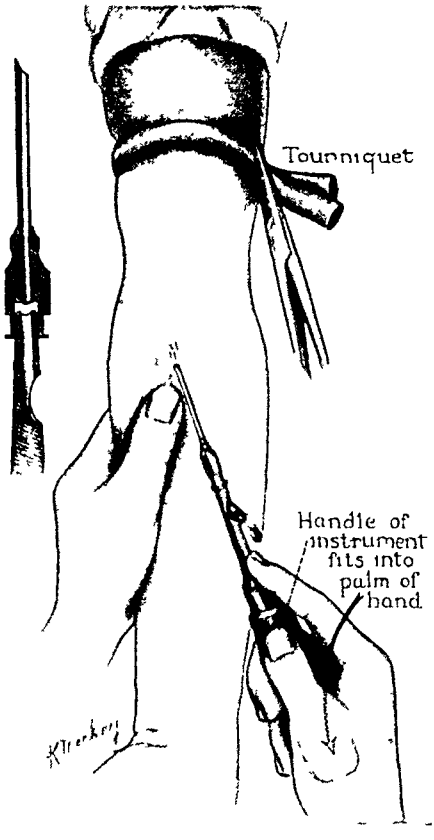


FIG 1.—Showing the mechanics of the device employed, and the method of its introduction into a vein

It has been my experience that venipuncture can best be performed by fixing the vein with the thumb, and, with the bevel of the needle up, the skin is punctured over the vein. A backward pull is then made on the plunger of the syringe as the vein is being entered. When the lumen of the vein is entered, blood fills the syringe. The disadvantages of using an ordinary syringe are: (1) The barrel, even with an eccentric tip, prevents the needle from being inserted parallel to the long axis of the vein by striking the arm or thumb; and (2) pulling back on the plunger while entering the vein may be an awkward procedure.

The device, as illustrated in Figure 1, obviates the above objections, in that the handle is of sufficient length so that the needle may easily parallel the vein, and when the lumen of the vein is entered blood immediately flows out of the perforated passage. The handle fits snugly into the palm of the hand where even pressure can be exerted, affording perfect control over the tip of the needle at all times.

Submitted for publication November 25, 1939.

DELAYED HEMORRHAGE FOLLOWING TRAUMATIC RUPTURE OF THE SPLEEN—WITH PARTICULAR REFERENCE TO ROENTGENOLOGIC FINDINGS*

CASE REPORT

J. MONTGOMERY DEAVER, M.D.

PHILADELPHIA, PA.

TRAUMATIC RUPTURE of the spleen and its attendant hemorrhage has become recognized as a definite, though somewhat unusual, clinical entity. It is also recognized that considerable variations in symptoms occur and that these variations depend upon the severity of the splenic injury, the quantity of blood lost, and the rate of blood loss. The patient may become exsanguinated as rapidly as when an aortic aneurysm bursts. Or, after an initial injury, the patient may exhibit obscure abdominal signs over a period of days or weeks, and gradually go down hill until the presence of continued internal hemorrhage is recognized and treated. Usually the initial injury is followed by a so-called latent period of a few hours, followed by the symptoms and signs of internal hemorrhage. Much more rarely this latent period continues over a period of days or weeks, the patient goes about his business, and the primary injury is ignored or even forgotten. Bleeding has stopped. Then, under strain of a slight rise in blood pressure, profuse secondary hemorrhage sets in, the patient is prostrated, and prognosis is grave.

This syndrome of delayed hemorrhage following traumatic rupture of the spleen has been reported by various authors. In 1932, McIndoe[1] published a report of such a case, and in addition collected 45 cases from the literature.

In contrast to the usual case of splenic rupture where the injury is severe, cases of delayed hemorrhage from splenic rupture usually have a comparatively slight primary injury. Direct violence to the left lower thorax or left upper abdomen is the common trauma although a case of delayed hemorrhage has been reported where the patient was thrown to the ground, striking the right side of the abdomen. Frequently fractures of the lower left ribs are present.

Symptoms are few and may be limited to transient dizziness. Collapse, followed by rapid recovery, has been reported. Pain over the spleen is frequently present. There may be radiation of pain to the left shoulder. The abdominal signs may be limited to slight epigastric or left upper quadrant rigidity. And in some instances no signs have been present and the patient complained only of a little discomfort or a dull ache in the left side.

The latent period in these cases is usually three to nine days. Rarely, it may be 14 or more days, and in one case on record it lasted six months. During the latent period a diagnosis can sometimes be made by persistent pain, tenderness,

* Read before a joint meeting of the New York Surgical Society and The Philadelphia Academy of Surgery, Philadelphia, February 14, 1940. Submitted for publication December 22, 1940.

rigidity, or signs of splenic enlargement. When secondary hemorrhage takes place, it often occurs spontaneously. At other times a minor effort such as straining at stool or bending over is sufficient. Apparently very little stress is required to break down whatever protective barriers may form in and around the injured organ.

When secondary hemorrhage occurs, variations between cases diminish and a rather uniform symptom sequence is found. Sudden severe pain, abdominal tenderness and rigidity, and the signs of shock develop rapidly. Death may occur before anything can be done. In patients who do not die at once, the signs of fluid in the abdomen, and an elevated left diaphragm can usually be found. Frequently there is radiation of pain to the left shoulder.

The prognosis is grave; operation is imperative. The mortality is in the neighborhood of 27 per cent. At the time of operation the spleen is often found widely torn or even shattered into several pieces, findings which attest to the violence of the secondary hemorrhage.

The present citation is of special interest because of the roentgenologic findings. Films were made at the time of secondary splenic hemorrhage, and after recovery.

Case Report.—A male, age 24, was admitted to the Abington Memorial Hospital, in December, 1939, complaining of pain in the back, the left shoulder and the abdomen. He had been riding in an automobile which had overturned, and, allegedly, he was unconscious for a short time after the accident. Examination revealed a young man suffering moderate pain. Examination showed fracture of the nose, left clavicle, left scapula, and left third and fourth ribs. There was lower abdominal tenderness with moderate rebound tenderness referred to the right lower quadrant. Some left upper quadrant pain was noted. No rigidity was present, no masses were felt, and no fluid could be demonstrated. Temperature 98.2° F.; pulse 80; respirations 26. Blood pressure 114/80. Blood count: 91 per cent hemoglobin; R.B.C. 4,490,000; W.B.C. 13,800; 86 polys, 11 lymph, 3 monos. Urine normal.

During the first 48 hours in the hospital the patient had slight right lower quadrant pain, and at one time he complained of transient left upper quadrant pain. Thereafter he had no abdominal symptoms. Pain in the left shoulder region was a prominent symptom, but the clavicular and scapular fractures could well have accounted for it. Eight days after the accident the patient was discharged to the Fracture Clinic.

Twenty days after the accident he reported to the clinic. Slight pain was still present in the left clavicular and scapular regions. In retrospect, the pain in the shoulder region might have prompted a diagnosis of ruptured spleen with perisplenic hematoma, but there were no abdominal symptoms or signs, and the pain was no more than one would expect from his injuries to the shoulder girdle.

All went well until 23 days after the accident when, during coitus, the patient suddenly experienced agonizing left upper quadrant pain. The pain was sharp, continuous and prostrating in severity. It quickly spread to the midline and then to the entire abdomen but the point of maximum severity remained in the left upper quadrant. He was seen by his family physician who sent him to the hospital with the diagnosis of ruptured peptic ulcer. At this time examination showed a pale, apprehensive man in severe pain. The skin was cool, the pulse was thin, the respirations costal in type. Diffuse abdominal tenderness was found, and it was most marked in the left upper quadrant. There was no radiation of pain to either shoulder. Generalized rigidity was also present, and was most marked in the left upper quadrant. Shifting dulness was elicited. The general picture bore some resemblance to acute pancreatitis and to ruptured peptic ulcer.

Temperature 98.2° F.; pulse 108; respirations 21. Blood pressure 124/92. Blood

count: 85 per cent hemoglobin; R.B.C. 4,000,000; W.B.C. 23,300; 95 per cent polys, 3 lymph, 2 monos.

A roentgenogram of the abdomen revealed no free air but showed tenting and elevation of the left dome of the diaphragm (Fig. 1). This finding was the most important single sign which led to the correct diagnosis. A diagnosis of secondary hemorrhage from a ruptured spleen was made and the patient was operated upon shortly after readmission to the hospital.

At operation, the peritoneum was slate-colored, and when it was opened huge quantities of blood and blood clots were noted throughout the abdominal cavity. Puddling of blood had occurred in both lumbar regions and in the pelvis. The spleen was somewhat enlarged and it was quite adherent to the lateral parietal peritoneum. A large gaping rent was oozing blood from the anterior splenic surface. Splenectomy was performed.

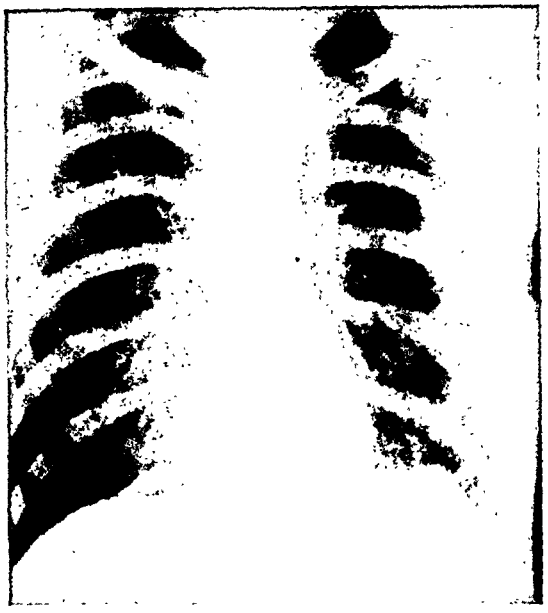


FIG. 1.—Preoperative roentgenogram showing tenting of left diaphragm.

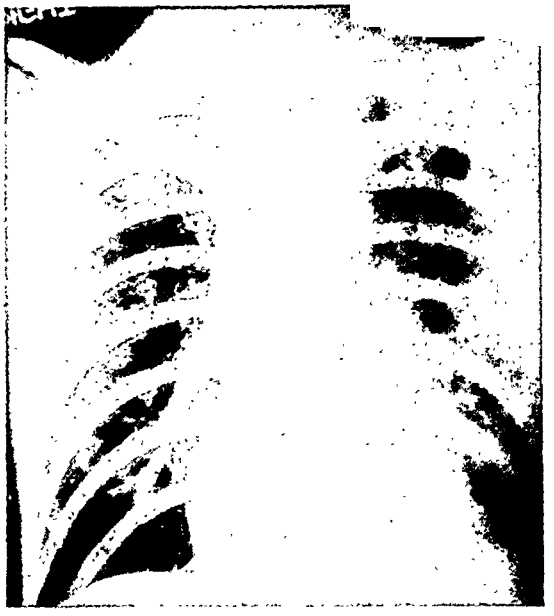


FIG. 2.—Postoperative roentgenogram showing a normal diaphragm.

After operation the patient was transfused on two occasions. His course was uneventful. A chest roentgenogram, taken before discharge, showed a normal diaphragm (Fig. 2).

In cases of delayed hemorrhage from the spleen the primary injury may be classified in three groups: (1) Minor superficial capsular rupture; (2) intrasplenic hematoma and subcapsular hemorrhage without capsular rupture; and (3) capsular and parenchymal rupture with perisplenic hematoma. In some cases the hematoma takes the form of a blood cyst. Tears of the hilum are usually followed by brisk and continuous hemorrhage. The case reported was one of capsular rupture with perisplenic hematoma.

This case illustrates a number of the characteristics of this syndrome as well as the difficulties in making a diagnosis before the final hemorrhage develops. The initial symptoms were quite characteristic. As often happens, signs were absent, and the symptoms were masked by other injuries. The latent period was somewhat longer than usual. When secondary rupture occurred, the specific signs of abdominal fluid and elevation of the left diaphragm, with tenting, were present in addition to the general signs of abdominal tenderness and rigidity, most marked in the left upper quadrant. There was no radiation of

pain to the left shoulder. The preoperative roentgenologic examination was particularly valuable in establishing the correct diagnosis. At operation, while the spleen was not actually fragmented, it was badly torn. Characteristic, were the presence of other injuries sustained at the time of primary splenic injury which masked the symptoms of primary splenic rupture.

REFERENCE

[1] McIndoe, A. H.: Delayed Haemorrhage Following Traumatic Rupture of the Spleen. Brit. Jour. Surg., 20, 249, 1932.

ERRATA

In the ANNALS OF SURGERY, 112, page 741, in the bibliographic reference 10, the term "neurolemmoma" should have been spelled "neurilemoma," which is the word originally employed by the author of the article, Dr. A. P. Stout.

CORRECTION

Article by John Scudder, M.D.: Studies in Blood Preservation, ANNALS OF SURGERY. 112:502–519, 1940, in Tables III, V and VI the last two items in headings below Composition should read ϕ/A and γ/A. The last two items below Mobilities, U x 10^{-5} should read ϕ γ.

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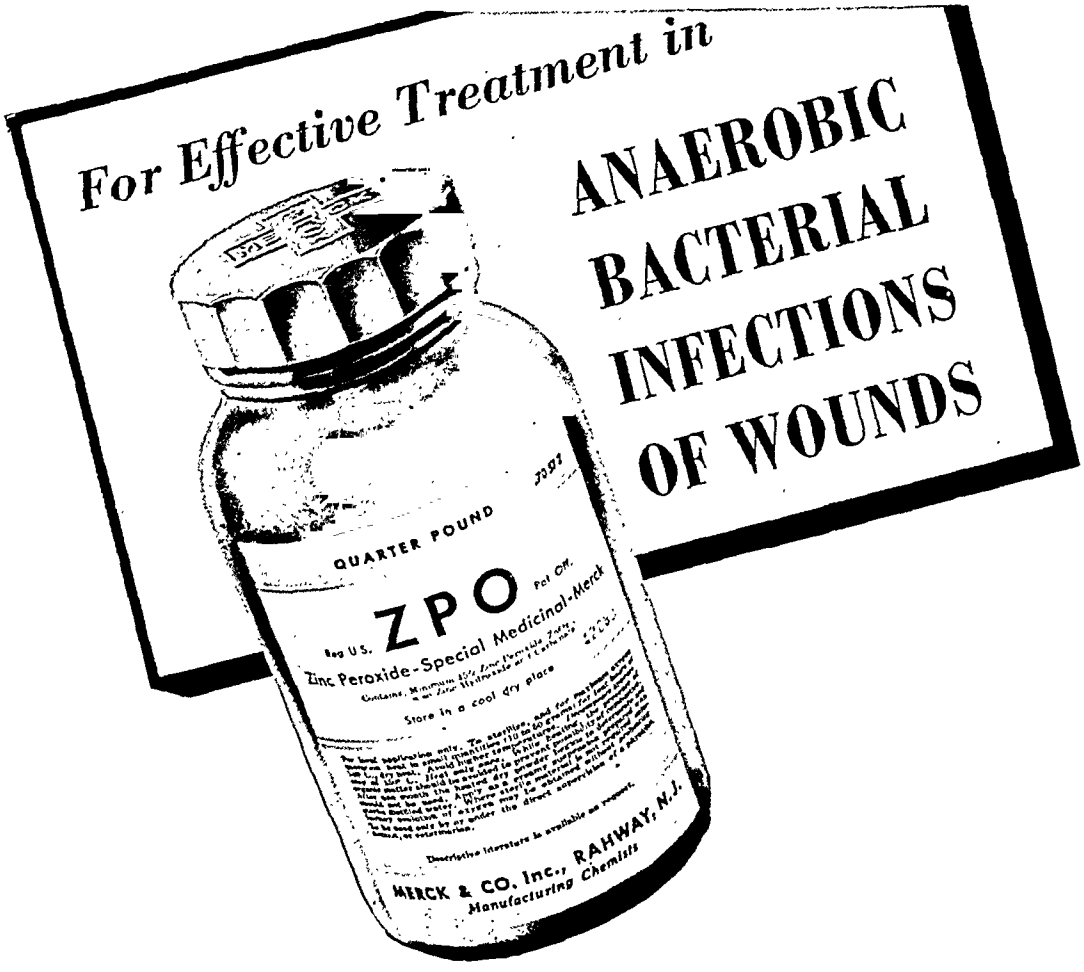
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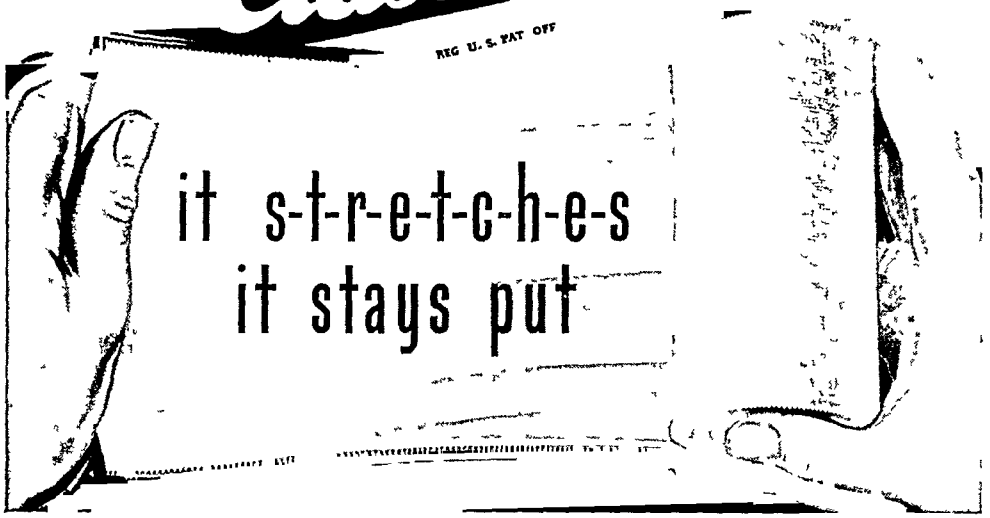
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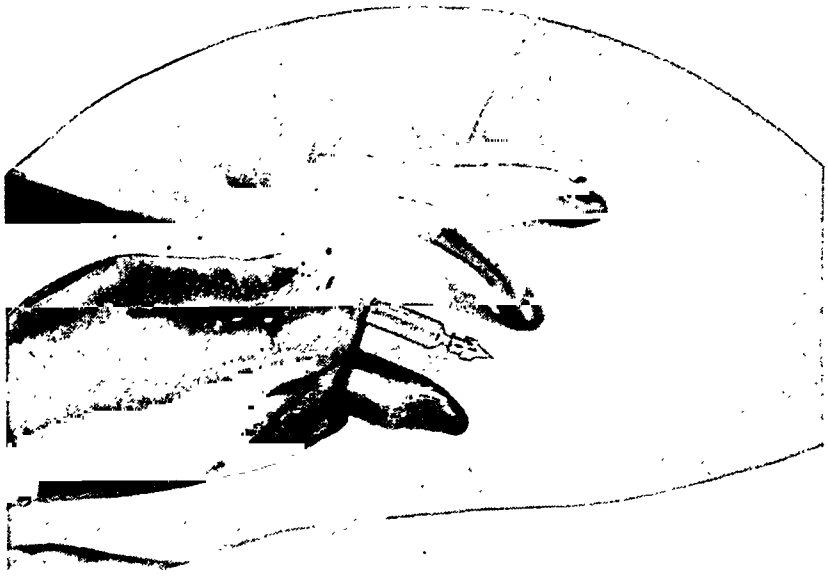


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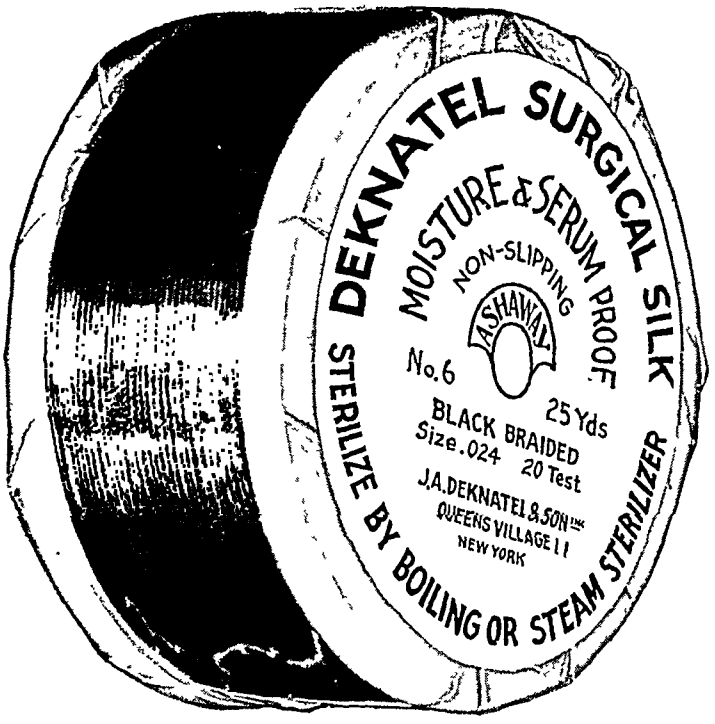
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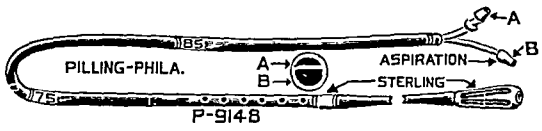
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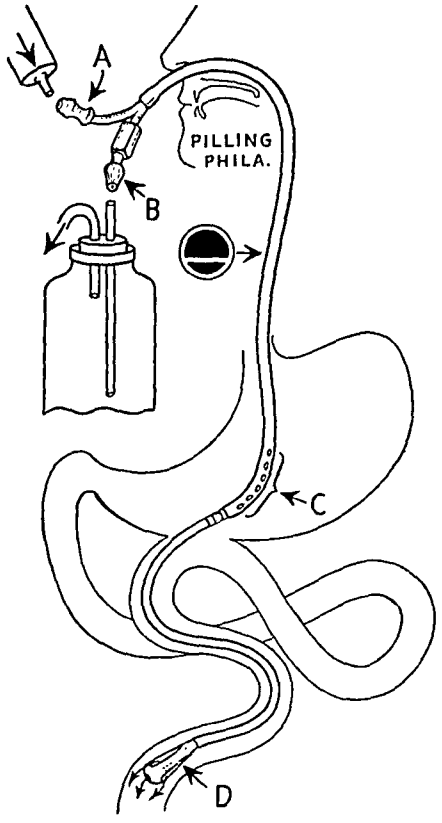
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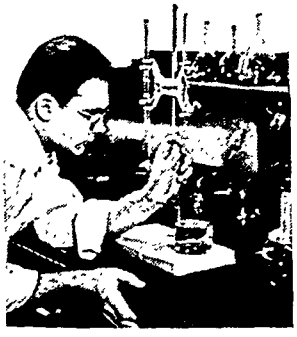
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CONTENTS

Vol. 113 APRIL, 1941 No. 4

ENDEMIC GOITER IN JAPAN..... Kunio Kawaishi, M.D.
Yoshio Hashimoto, M.D.
Taihoku, Formosa, Japan 481

SURGERY OF THE THYROID IN A LARGE MUNICIPAL HOSPITAL..... Roderick V. Grace, M.D.
Carnes Weeks, M.D.
New York, N. Y. 496

BRANCHIAL CYSTS AND SINUSES..... Frank H. Lahey, M.D.
Harlan F. Nelson, M.D.
Boston, Mass. 508

INTRA-ABDOMINAL APOPLEXY..... J. Edward Berk, M.D.
N. S. Rothschild, M.D.
J. C. Doane, M.D.
Philadelphia, Pa. 513

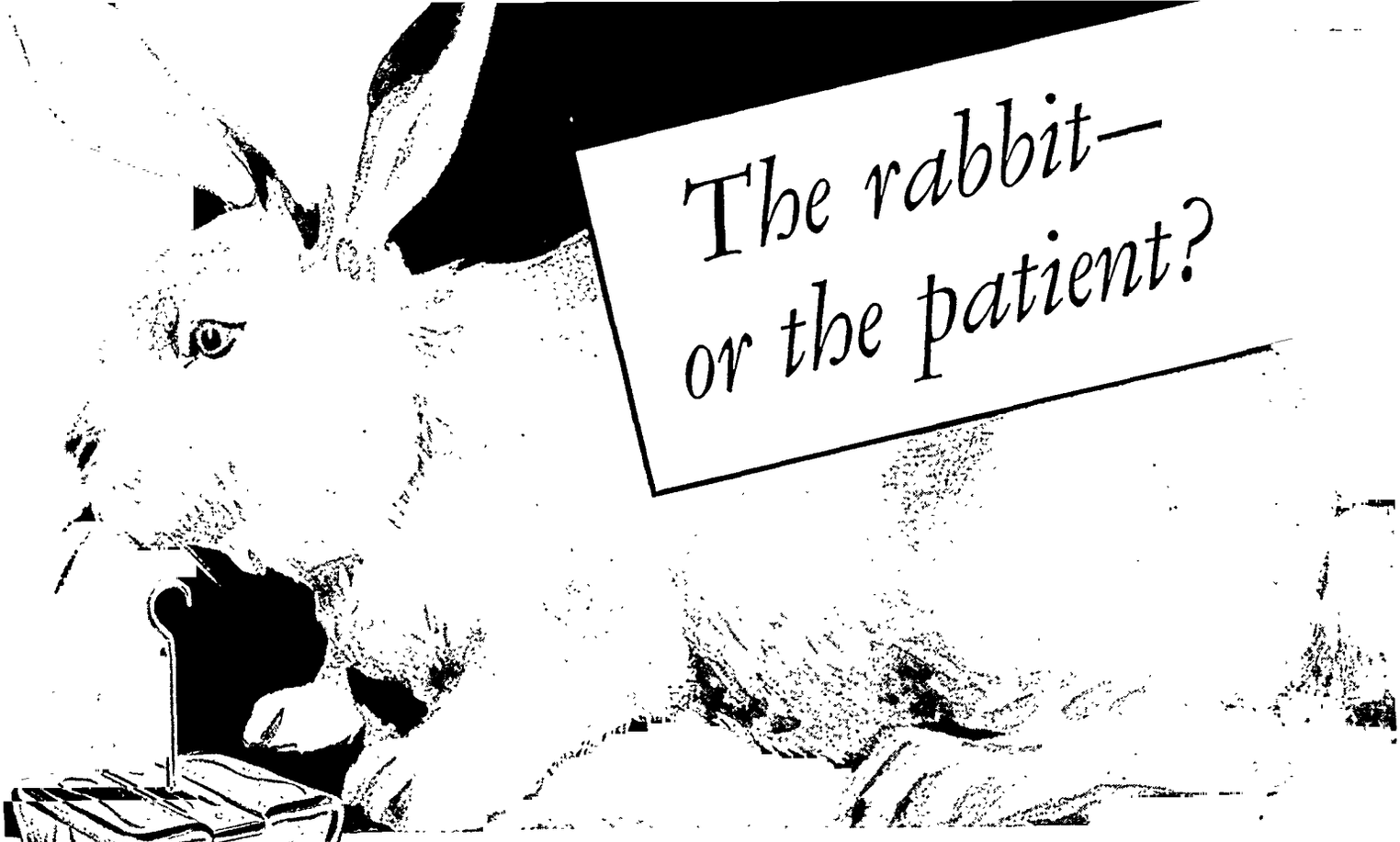
INTRACTABLE GASTRIC ULCER WITH FINAL MALIGNANT CHANGE ASSOCIATED WITH A BENIGN TUMOR OF THE BRAIN..... P. H. T. Thorlakson, M.D.
Sarah Meltzer, M.D.
Winnipeg, Canada 521

GIANT DIVERTICULUM OR DUPLICATION OF THE INTESTINE WITH RECURRENT PERFORATIONS..... John W. Duckett, M.D.
Dallas, Texas 528

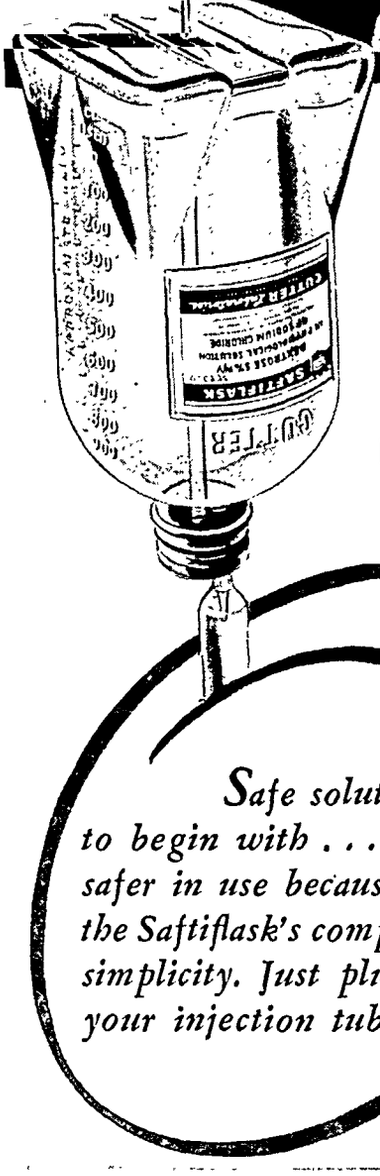
TOPOGRAPHY AND DEVELOPMENT OF THE CECUM-APPENDIX..... Charles F. De Garis, M.D.
Oklahoma City, Okla. 540

BENIGN TUMORS OF THE OVARY ASSOCIATED WITH ASCITES AND PLEURAL EFFUSION..... William F. MacFee, M.D.
New York, N. Y. 549

(Contents continued on page 4)



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STUDIES ON THE CEREBROSPINAL FLUID PRESSURE IN UNANESTHETIZED DOGS..... John E. Webster, M.D.
Norman E. Freeman, M.D.
Philadelphia, Pa. 556

THE INDUCTION OF LIVER NECROSIS IN RABBITS BY THE COMBINATION OF EXPERIMENTAL HYPERTHYROIDISM AND SHOPE PAPILLOMA..... W. C. Sealy, M.D.
Durham, N. C. 572

PERINEAL PROSTATOTOMY AND PROSTATECTOMY FOR THE REMOVAL OF PROSTATIC CALCULI..... Robert Gutierrez, M.D.
New York, N. Y. 579

HYDROCELE OF THE CANAL OF NUCK..... Virgil S. Counseller, M.D.
B. Marden Black, M.D.
Rochester, Minn. 625

BRIEF COMMUNICATIONS AND CASE REPORTS

PARTIAL GASTRIC RESECTION FOR CARCINOMA Frank Glenn, M.D.
New York, N. Y. 631

GUNSHOT WOUND THROUGH THE ABDOMINAL AORTA Borris A. Kornblith, M.D.
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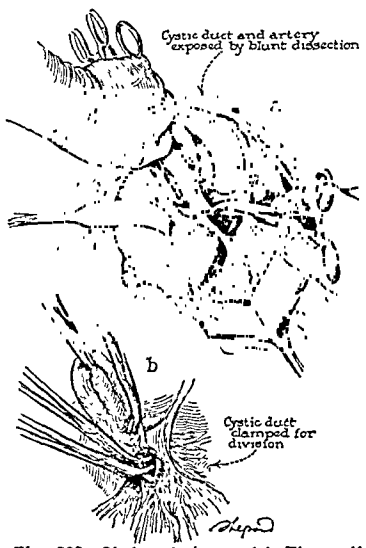


Fig. 232. Cholecystectomy. (a) The cystic duct and cystic artery are being dissected free from the tissues of the duodenal-hepatic ligament with the tip of a Moynihan forceps; (b) the cystic duct is doubly clamped with Moynihan forceps. (Illustration reduced from original.)

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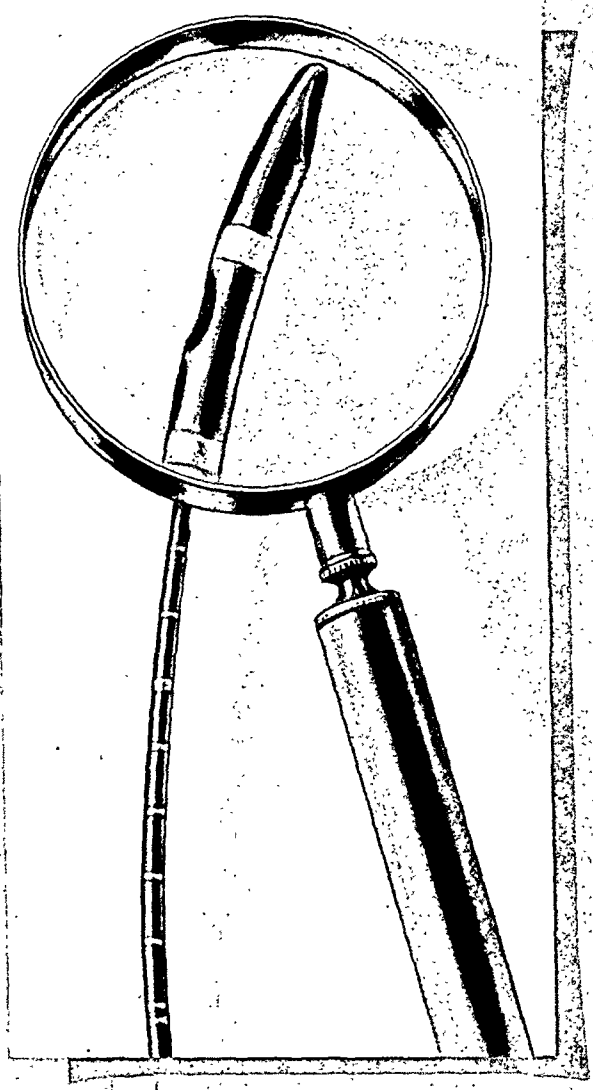
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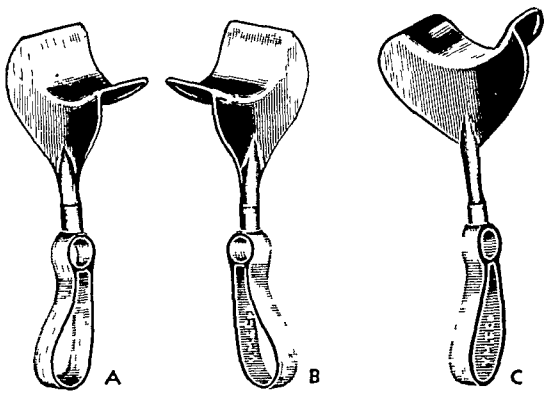
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INDEX TO ADVERTISERS

	Page
SURGICAL SUPPLIES	
American Cystoscope Makers, Inc.	5
Bard-Parker Company, Inc.	11
Rudolph Beaver	21
Clay-Adams	21
Cutter Laboratories	3
Macalaster Bicknell Company	9
V. Mueller & Co.	6
George P. Pilling & Son Co.	10, 19
LIGATURES	
Davis & Geck, Inc.	Insert, 8-9, 16
C. De Witt Lukens Co.	16
Deknatel	12
Johnson & Johnson	15
PHARMACEUTICAL SUPPLIES	
Anglo-French Drug Co., Inc.	Inside Front Cover
Armour & Company	17
Ciba Pharmaceutical Products, Inc.	Back Cover
Duke Laboratories, Inc.	10
Hoffmann-La Roche, Inc.	7
Parke, Davis & Company	13
Purdue Frederick Company	19
Schering Corporation	Inside Back Cover
Winthrop Chemical Co., Inc.	8
PUBLISHERS	
Journal of Bone and Joint Surgery	24
Lea & Febiger	20
J. B. Lippincott Company	12, 14, 21, 22, 23
C. V. Mosby Company	18
SCHOOL	
Chicago Post-Graduate School of Surgery	4
HOTELS	
Chalfonte-Haddon Hall	12



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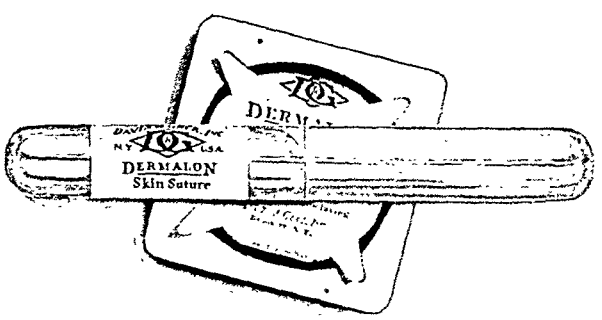


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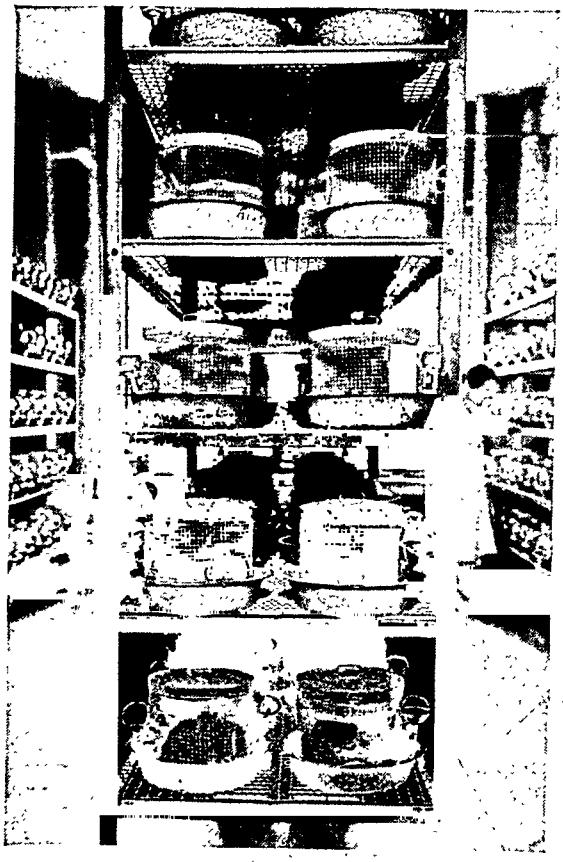


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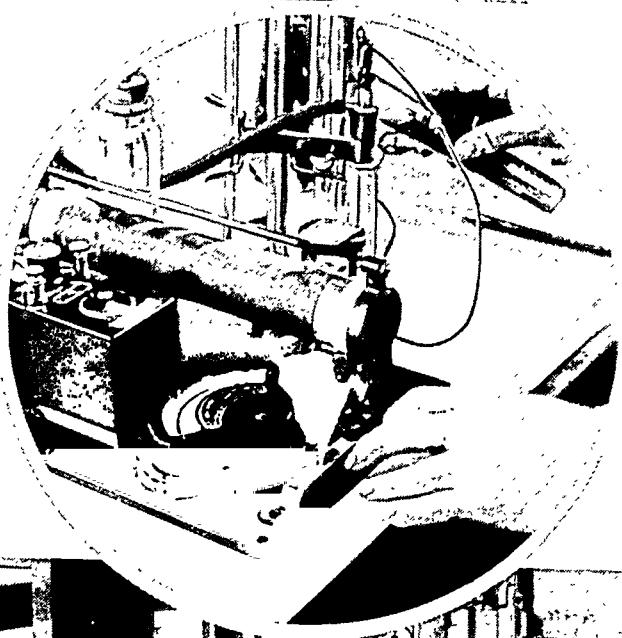
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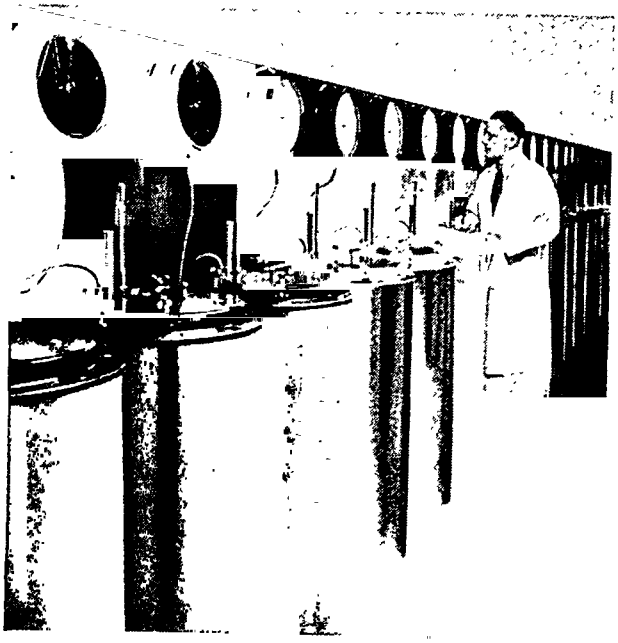
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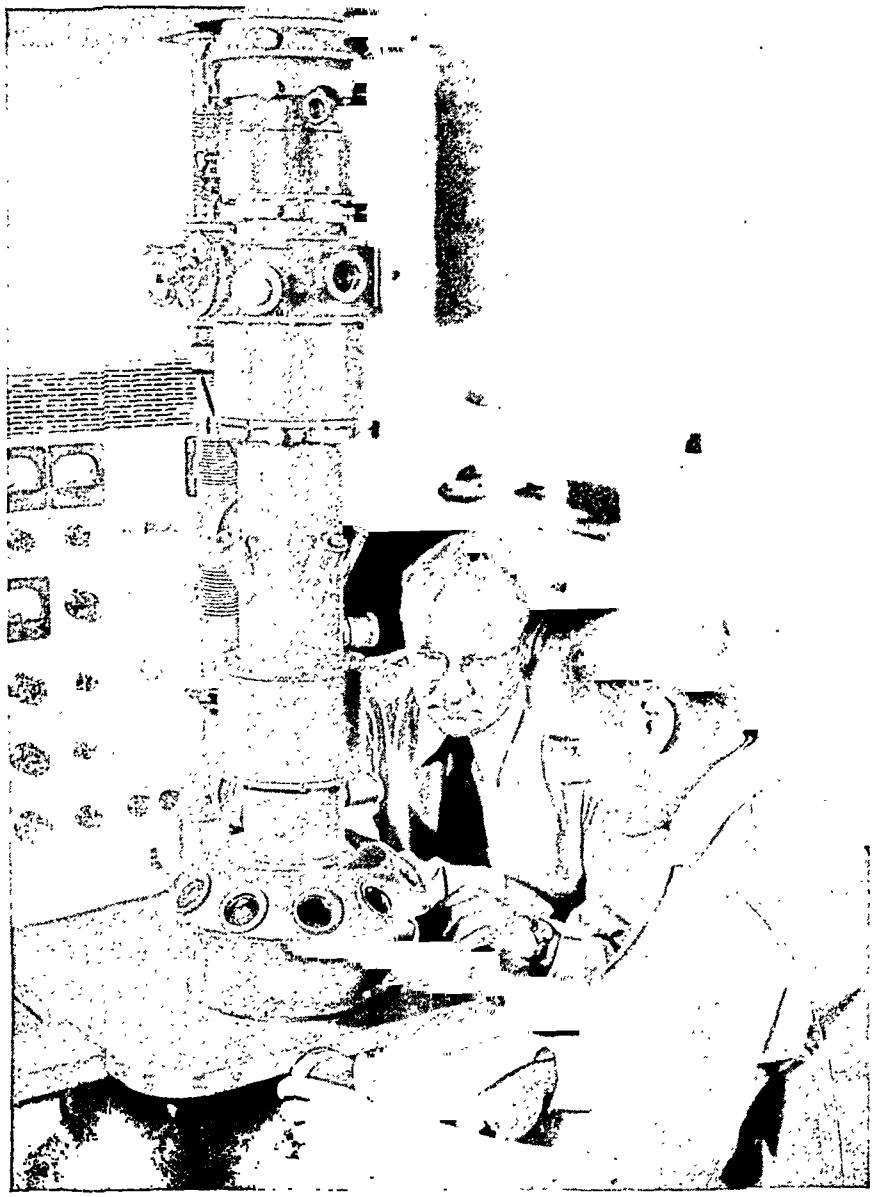








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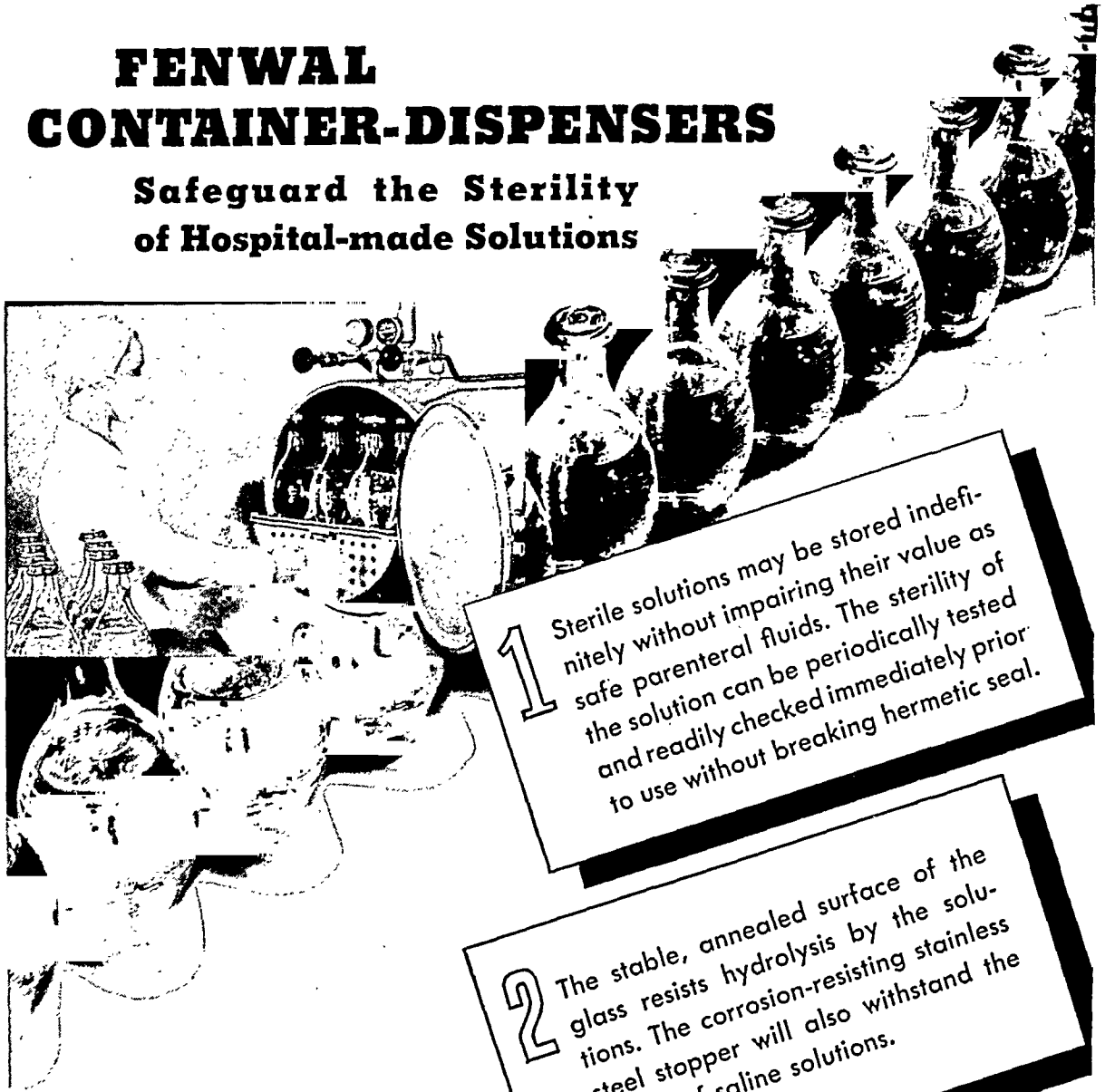
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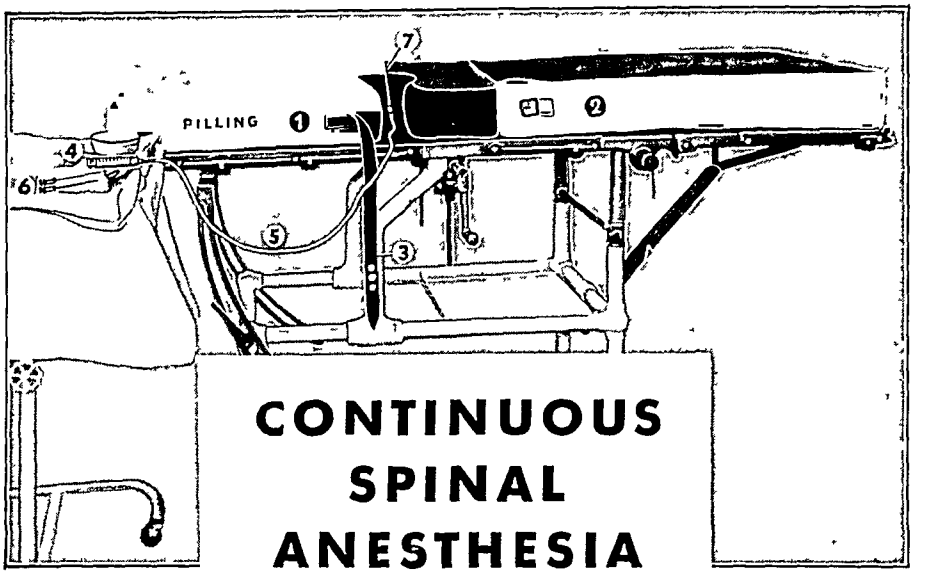
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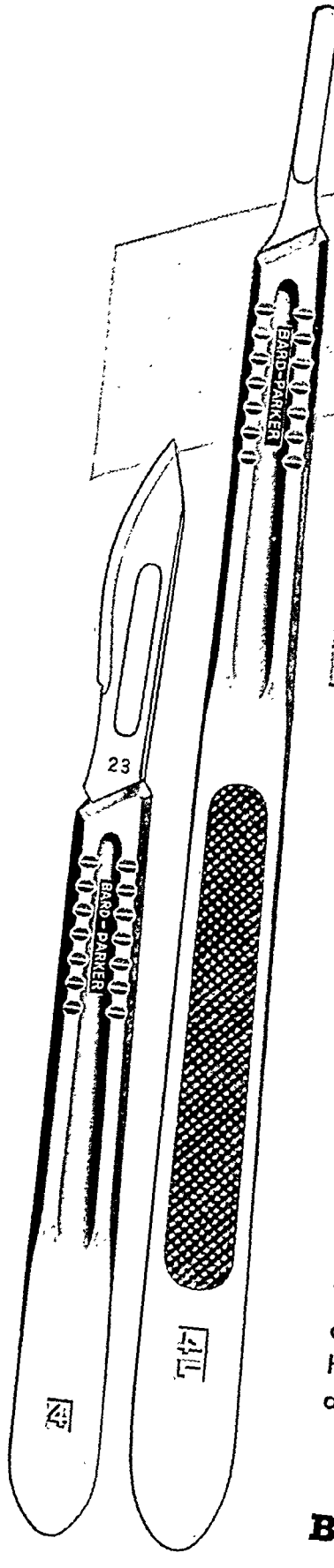
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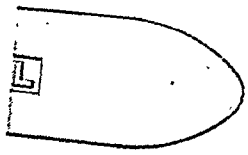
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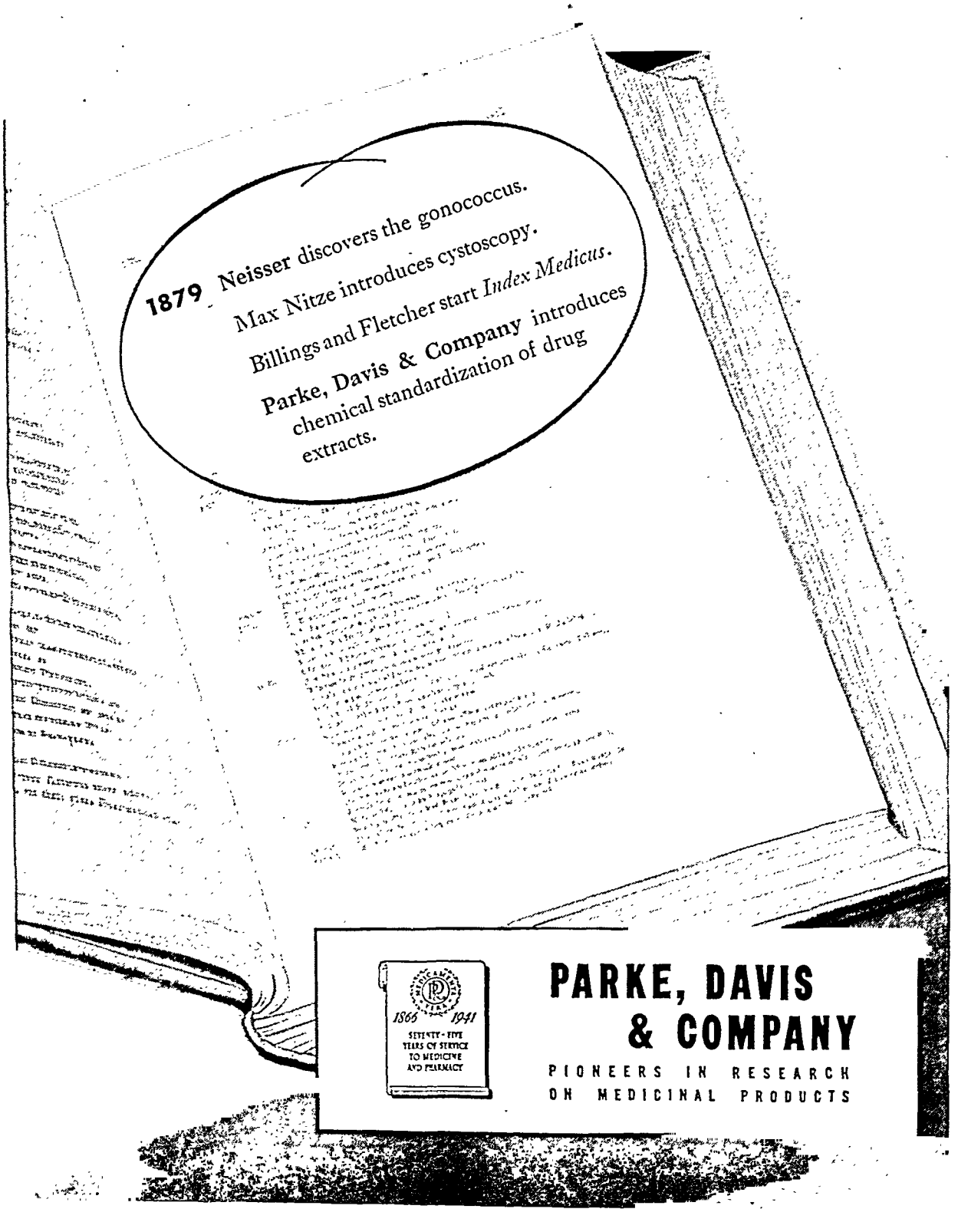
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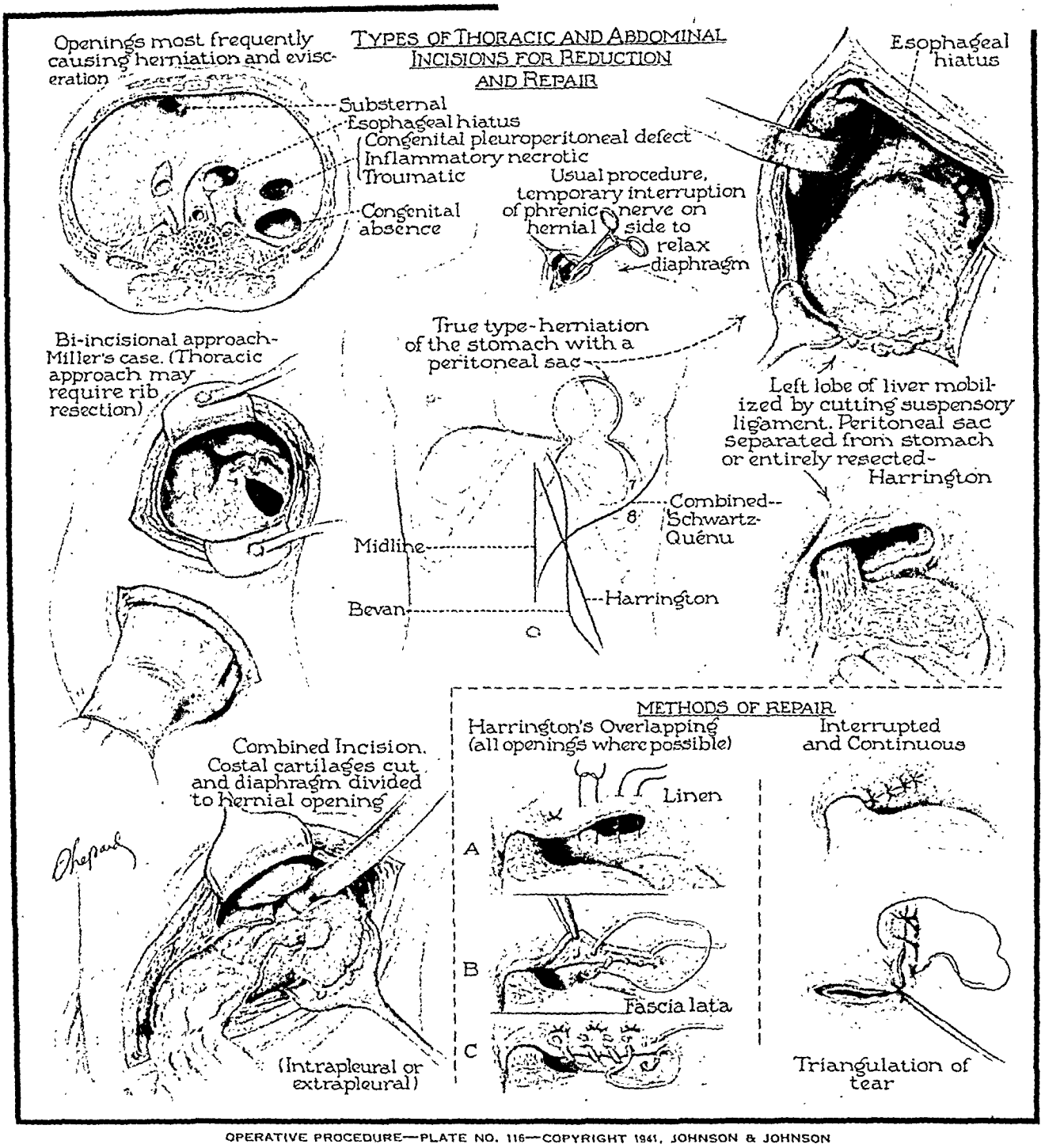
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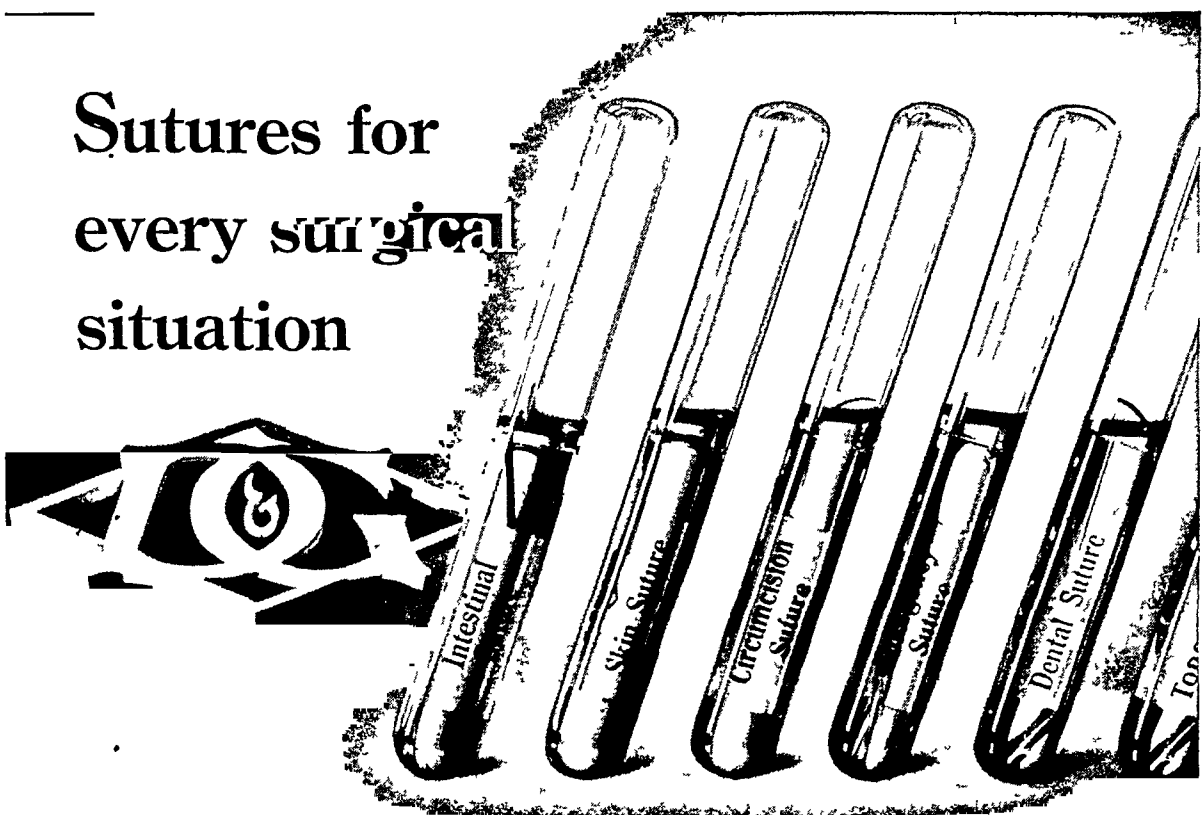
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ANNALS OF SURGERY

VOL. 113 APRIL, 1941 No. 4

ENDEMIC GOITER IN JAPAN*

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IT is well known that goiters are unusual in Japan and it is commonly believed that there are no endemic goiter regions such as are present in Switzerland. Dr. E. Papellier,[1] who has resided in Japan for 50 years, reported, in 1938, on the occurrence of goiters in Japan, and attributed the scarcity of the disease to the high iodine content of the diet in which sea-weeds are constantly used.

Dr. J. F. McClendon,[2] who resided in Japan for one year, as exchange professor, described the mountainous districts of Honshu (main island) and Hokkaido, Japan, as the goitrous areas, in 1935. But his so-called goitrous area is such that only five goiters were found among a population of 2,500. Formosa, which he described as a nongoitrous area, is, in fact, the only real endemic goitrous area in Japan.

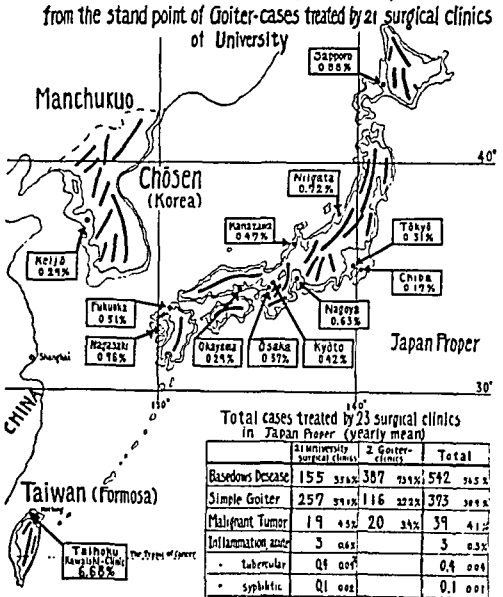
A. DISTRIBUTION OF GOITER IN JAPAN PROPER.—In order to get some idea of the relative distribution of goiter in Japan, the authors have inquired and received information from 21 University Surgical Clinics, and from two Goiter Clinics of our country, in regard to the goiters treated during the last five years. Table I represents the distribution of goiters as obtained from the above information. As shown in the map, 0.17 to 0.88 per cent of all surgical cases in the University Clinics are goiters, and there is little difference among the various parts of Japan. The total number of goiters operated upon yearly in the 21 University Surgical Clinics does not exceed 435 cases, and likewise in the two Goiter Clinics it does not exceed 523 cases. The total of these clinics is 958 cases, out of which 38.9 per cent are simple goiters and 56.5 per cent are Basedow's disease and hyperthyrosis. In the Goiter Clinics, Basedow's disease and hyperthyrosis predominate and only 22.2 per cent are simple goiters.

*Read before the Third Pan-Pacific Surgical Congress, September 21, 1939, at Honolulu, Hawaii. Submitted for publication October 18, 1939.

TABLE I

Distribution of Goiter in Japan

from the stand point of Goiter-cases treated by 21 surgical clinics of University



Total cases treated by 23 surgical clinics in Japan Proper (yearly mean)

	21 University surgical clinics		2 Goiter-clinics		Total	
Basedows Desease	155	32.8%	387	73.9%	542	56.5%
Simple Goiter	257	59.1%	116	22.2%	373	38.9%
Malignant Tumor	19	4.3%	20	3.8%	39	4.1%
Inflammation ante	3	0.6%			3	0.3%
・ tubercular	0.9	0.2%			0.9	0.09%
・ syphilitic	0.1	0.02%			0.1	0.01%
Total	434.5	100%	523.0	100%	957.5	100%

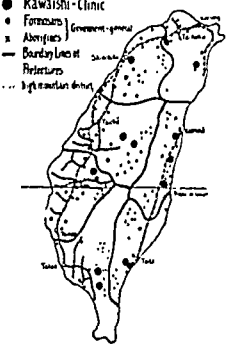
TABLE II

The Materials on which this Report is based.

	Number Examined	Number of Goiter	Rate of Affection in % Total	Male	Female	♂ : ♀
The Examination of Kawaishi-Clinic in 13 endemic Regions	56082	19792	35.2%	26.1%	44.9%	1 : 1.7
in out patients of 5 years duration	1989	1331	66%	08%	13.4%	1 : 16.9
Total	58071	19925	34.3%	25.2%	43.9%	1 : 1.7
The examination of the government-general Formosans	193996	5540	2.8%	0.8%	4.9%	1 : 5.8
Aborigines	65717	1465	2.2%	0.6%	3.6%	1 : 4.5
Simple Goiters treated by 21 University-Hospitals and 2 Goiter-Clinics of proper Japan (yearly mean)		373	0.4%	0.14%	0.62%	1 : 4.4

Regions of Examination.

Explanations
- Kawaishi-Clinic
- Formosans
- Aborigines
- Boundary Line of Prefectures
- Government-general



The Cases operated during the past one year in Kawaishi-Clinic.

	Race	Total	Male	Female
Endemic Goiter	Japanese Proper	8	1	7
	Formosans	23	2	21
	Aborigines	39	4	35
	Total	70	7	63
Basedow's disease	Japanese Proper	5		5
	Formosans	4	2	2
	Aborigines	0		
	Total	9	2	7
Cancer	Formosans	1	1	
	Aborigines	1		1
Cretin	Formosans	1		1
Total		82	10	72

TABLE III

Results of Examination in endemic Regions.

15681 Goiters out of 49011 Persons. Rate: 31.9 %

Race	Region	Examined Persons	Goiter	Rate of Affektion % Total	♂	♀	♂ : ♀
Japanese Proper	Shirakawa (Karenkō)	45	10	22.2%	19.0%	25.0%	1 : 1.3
	Yoshino (・)	966	131	13.5%	10.2%	16.0%	1 : 1.5
	Kamiyamato (・)	165	13	7.8%	4.0%	13.6%	1 : 3.4
	Ōka (Taihoku)	73	4	5.4%	0.	12.5%	
	Jurin (・)	178	1	0.5%	0.	1.1%	
	Total	1427	159	11.1%	7.6%	14.2%	1 : 1.8
Formosans.	Rokka (Shinchiku)	8111	3862	47.6%	31.5%	63.7%	1 : 2.0
	Mori (Taichū)	892	358	40.1%	27.3%	52.7%	1 : 1.9
	Ōka (Taihoku)	25212	6200	26.7%	18.8%	35.3%	1 : 1.8
	Sansei (・)	1107	245	22.1%	11.2%	32.9%	1 : 2.9
	Koume (Tainan)	1784	362	20.6%	10.1%	27.1%	1 : 2.6
	Pinam (Taito)	1768	288	16.2%	10.3%	23.6%	1 : 2.2
	Mōrin (Karenkō)	230	32	13.9%	7.2%	23.6%	1 : 3.2
	Total	37104	11347	30.5%	20.6%	41.2%	1 : 2.0
Aborigines.	Mizuho (Karenkō) Ami	1722	1093	63.5%	44.8%	76.8%	1 : 1.7
	Mōrin (・) ・	4184	2238	53.5%	31.8%	71.8%	1 : 2.2
	Kantaban (Taichu) Bunun	104	47	45.2%	?	44.6%	
	Painam (Taito) Bunun	368	120	32.6%	21.4%	42.0%	1 : 1.9
	Rai (Takao) ・	691	135	19.5%	16.1%	23.1%	1 : 1.4
	Makazayaza (・) ・	1176	198	16.8%	12.2%	21.6%	1 : 1.7
	Pinam (Taito) ・	1923	330	17.1%	11.5%	21.8%	1 : 1.8
	Pinam (・) Ami	88	4	4.5%	4.8%	4.2%	1 : 0.8
	Mizuho (Karenkō) Bunun	222	10	4.5%	2.7%	6.1%	1 : 2.2
	Total	10480	4175	39.8%	25.4%	52.2%	1 : 2.0

TABLE IV

Results of Examination in Primary School and Public School.

4111 Goiters out of 7071 Pupils. Rate: 58.1%

Race	School.	Number of Pupils.	Goiters	Rate of Affection in % Total.	♂	♀	♂ : ♀
Japanese Proper	Kamiyamato Primary School (Karenkō)	112	41	36.6%	30.1%	44.8%	1 : 1.4
	Yoshino ・	313	86	27.4%	21.6%	32.7%	1 : 1.5
	Total	425	127	29.8%	24.1%	35.5%	1 : 1.4
Formosans.	Rokka Public School (Shinchiku)	692	571	82.5%	80.8%	87.2%	1 : 1.1
	Shirakawa ・ (Karenkō)	336	275	81.8%	79.2%	88.4%	1 : 1.1
	Kan-en ・ (Taihoku)	462	328	70.9%	67.4%	75.8%	1 : 1.1
	Rika ・ (Taitō)	36	25	69.4%	70.0%	68.7%	1 : 0.9
	Jurin ・ (Taihoku)	1255	799	63.6%	57.8%	71.3%	1 : 1.2
	Chippon ・ (Taitō)	115	69	60.0%	52.3%	69.2%	1 : 1.3
	Mōzan ・ (Shinchiku)	69	36	52.1%	41.6%	76.1%	1 : 1.8
	Tomida ・ (Karenkō)	107	53	49.5%	38.7%	64.4%	1 : 1.6
	Taiko ・ (Taihoku)	217	102	47.0%	44.6%	50.0%	1 : 1.1
	Senzan ・ (・)	1248	551	44.1%	42.5%	46.3%	1 : 1.1
	Kamiyamato ・ (Karenkō)	219	88	40.1%	36.0%	46.9%	1 : 1.3
	Total	4757	2896	60.8%	58.3%	64.8%	1 : 1.1
Aborigines.	Shirakawa Public School (Karenkō)	189	184	97.3%	97.5%	97.0%	1 : 1.0
	Kamiyamato ・	296	225	76.0%	71.8%	80.8%	1 : 1.1
	Tomida ・	496	313	63.1%	50.1%	76.5%	1 : 1.5
	Rika ・ (Taitō)	62	37	59.6%	55.2%	66.6%	1 : 1.2
	Chippon ・	80	47	58.7%	54.3%	63.8%	1 : 1.1
	Nōkō ・ (Taichū)	144	83	57.6%	48.0%	52.0%	1 : 1.1
	Makazayaza ・ (Takao)	258	103	39.9%	33.6%	47.4%	1 : 1.4
	Rai ・	190	63	34.2%	37.5%	30.9%	1 : 0.8
	Mahoan ・ (Karenkō)	174	31	17.8%	13.4%	21.9%	1 : 1.6
	Total	1689	1088	57.5%	53.5%	62.4%	1 : 1.1

Dr. Y. Okano,[5] of the Kyoto Imperial University Hospital, reported 283 goiter cases from various Medical, Pediatric, Surgical, and Gynecologic Clinics, and showed the same relation in which Basedow's disease and hyperthyrosis correspond to 53.4 per cent of all goiters. In other words, it is evident that Basedow's disease and hyperthyrosis are prevalent in Japan proper, and simple goiters are seen only sporadically. This finding corresponds to the situation in Hamburg, Germany, where hyperthyreoses are found

TABLE V

The Geographical Distribution of Goiters.

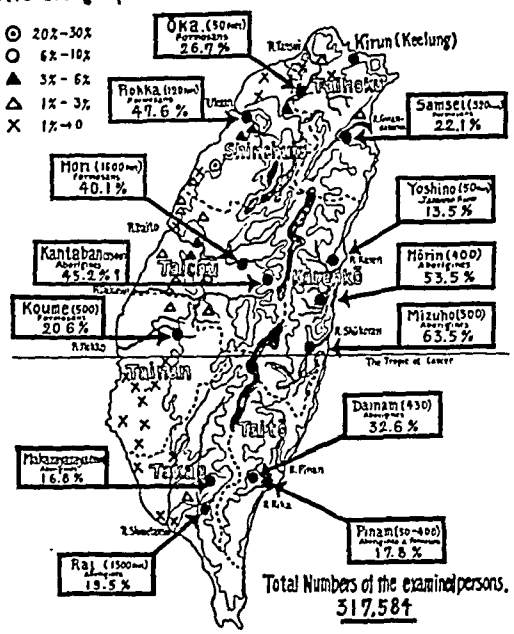


TABLE VI

Per Cent Affected Among Races.

Japanese Proper	18.0%
Formosans	44.7%
Aborigines	61.1%

1. 2.5 3.4

School children.

Region	Japanese Proper	Formosans	Aborigines
Kamiyamato School	36.6%	40.1%	76.0%
Tomida ·		49.5%	63.1%
Shirakawa ·		81.8%	97.3%
Rika ·		69.4%	59.6%
Chippon ·		60.0%	58.7%

Non school children.

Region.	Japanese Proper	Formosans	Aborigines
Shirakawa	22.2%		63.5%
Kamiyamato.	7.8%	13.9%	53.5%
Ōka	5.4%	26.7%	
Pinam		16.2%	17.1%

in 50 per cent of all goiters. As in the other countries, hyperplastic thyroids at puberty are seen generally in Japan.

During the past one and one-half years our clinic has surveyed the endemic goiter in Formosa, which, at this time, we wish to report in full.

B. Endemic Goiter in Formosa.—(1) *Material Considered* (Tables I, II, III and IV).—This report is based on 19,925 goiters examined at our Out-Patient Clinic and also observed during the survey conducted by us in the 13 endemic regions. In addition, it is based on 6,955 goiters which had been reported ten years before by the governor general of Formosa from a survey of all native and 54 Formosan villages. According to our survey, the disease rate is 44.9 per cent, a rather high rate, because the investigation was conducted only in the highly endemic regions. On the other hand, the reported rate of the government survey is 2.2 to 2.8 per cent. This low rate may be accounted for by the fact that: (1) The survey was conducted either in the nonendemic regions; or (2) slight swellings of thyroids in children were overlooked. Hence, if the survey had been properly carried out, the rate should have been three times as high.

(2) *Geographic Distribution* (Table V).—Primarily, it is essential to

describe the geographic features and climate of Formosa. Formosa extends both into the tropical and subtropical zones, with the tropic of Cancer passing through its center. The greater portion of the island is mountainous, and it is a trifle smaller than Switzerland. A mountain range, occupying the middle of the island, extends from north to south, thus dividing the island into an eastern and western portion. Furthermore, there is a small sea coast range running parallel to the former in the eastern part of the island. The former range has a very high altitude and is formed by 48 mountain peaks of over 10,000 feet, the highest being 13,000 feet.

The Japanese proper and the Formosans live on the plains, while the Aborigines live mostly in the mountainous districts. Goiters are found all over the island but are, however, more prevalent in the subtropical, northern section than the tropical, southern section. The highest rate of incidence (Tables II, III and IV) is 63.5 per cent of the total population, out of which, 78.8 per cent, are found in the female, when only the female population is considered (Shirakawa of Mizuho). There are five endemic regions with disease rates of over 40 per cent; one with 32.6 per cent; three with 20 to 30 per cent; and four with 10 to 20 per cent.

Goiters are prevalent in the regions of the foothills in general, while along the seacoast they are very infrequent. The highly endemic regions, such as Shirakawa of Mizuho (Aborigines 63.5 per cent), Kamiyamato and Tomida of Hōrin (Aborigines 53.5 per cent), Oka (Formosans 26.7 per cent), Rokka (Formosans 47.6 per cent), Kokkan (26.2 per cent), Koume (Formosans 20.6 per cent), Sansei (Formosans 22.1 per cent), *etc.*, are located at the foot of the mountains, situated at 50 to 750 feet above sea level. Hori, the highest Formosan village, situated at 1,600 feet above sea level, has a very high rate of 41.1 per cent.

In the mountainous districts above 3,700 to 4,000 feet above sea level, where the Aborigines reside, many goiters are found. This fact indicates that the height of the village has no relation to the endemic nature of goiter. Furthermore, the type of goiter is not influenced by the height. The so-called "mountain-goiters," or multiple nodular goiters, are seen not only in the mountainous regions but also in places of low elevations of 50 to 500 feet, namely, Mizuho, Horin, Oka, *etc.* In one village the diffuse type may be prevalent, while in the others the nodular type may be more common. The different types of goiter depend rather on the district, race, and food, to which we shall refer later on.

(3) *Incidence Rate in Different Races* (Table VI).—There are different tendencies in respect to the affection among the three races in Formosa. The Japanese proper are less involved; the Formosans come second, and the Aborigines are highly susceptible. The percentages of incidence in each race, in the six most populated endemic regions, are 18.0, 44.7 and 61.1 per cent, namely, 1:2 and 5:3.5. This difference is due to the diet and mode of life of these different races. For example, the Japanese proper use seafoods in great quantity in the diet while the others rarely use them.

TABLE VII.

Ratio of goitrous female to male in age.

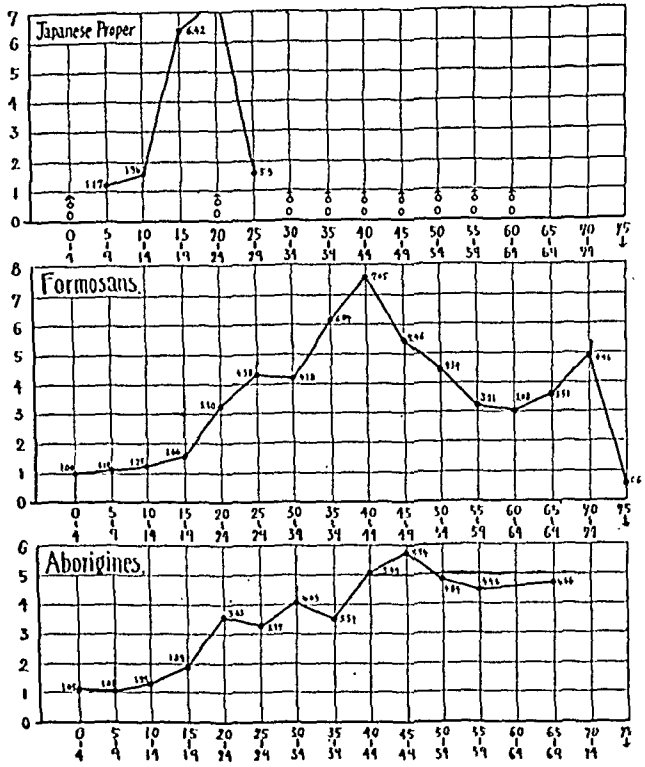


TABLE VIII.

Per Cent of Affection According to Age.

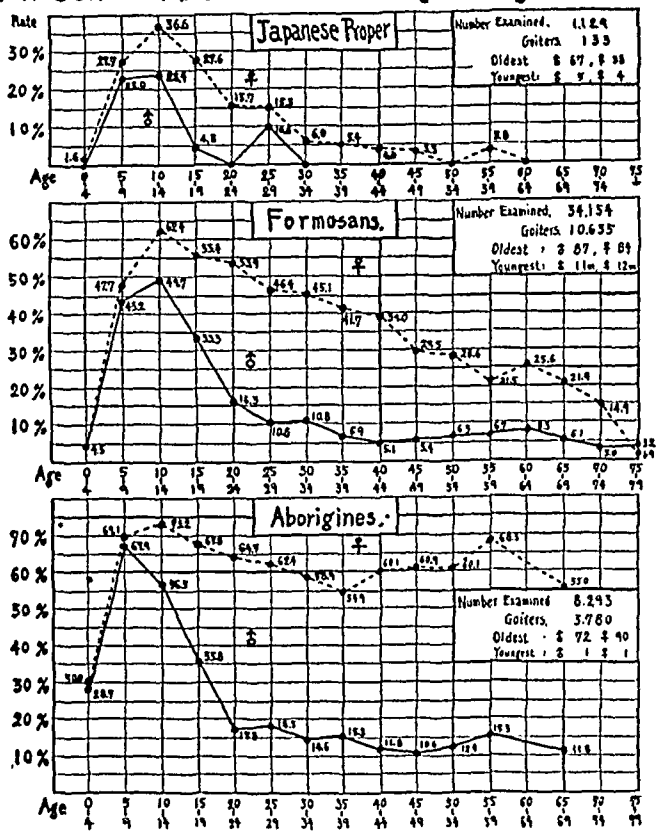
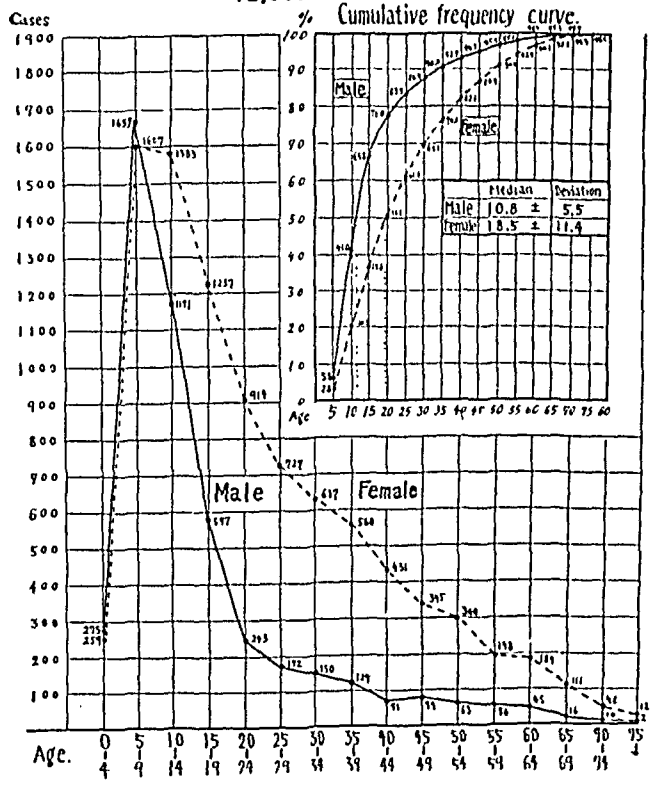


TABLE IX

Number of Goiters According to Age.

13,866 Goiters.



Among the nine native tribes, different disease rates are found. The Ami, who live in the plains of the eastern part, show the highest rate of affection, namely, 63.5 per cent (Shirakawa and Turuoka of Mizuho) and 53.5 per cent (Kamiyamato and Tomida of Horin). The Bunun and the Zuo, who

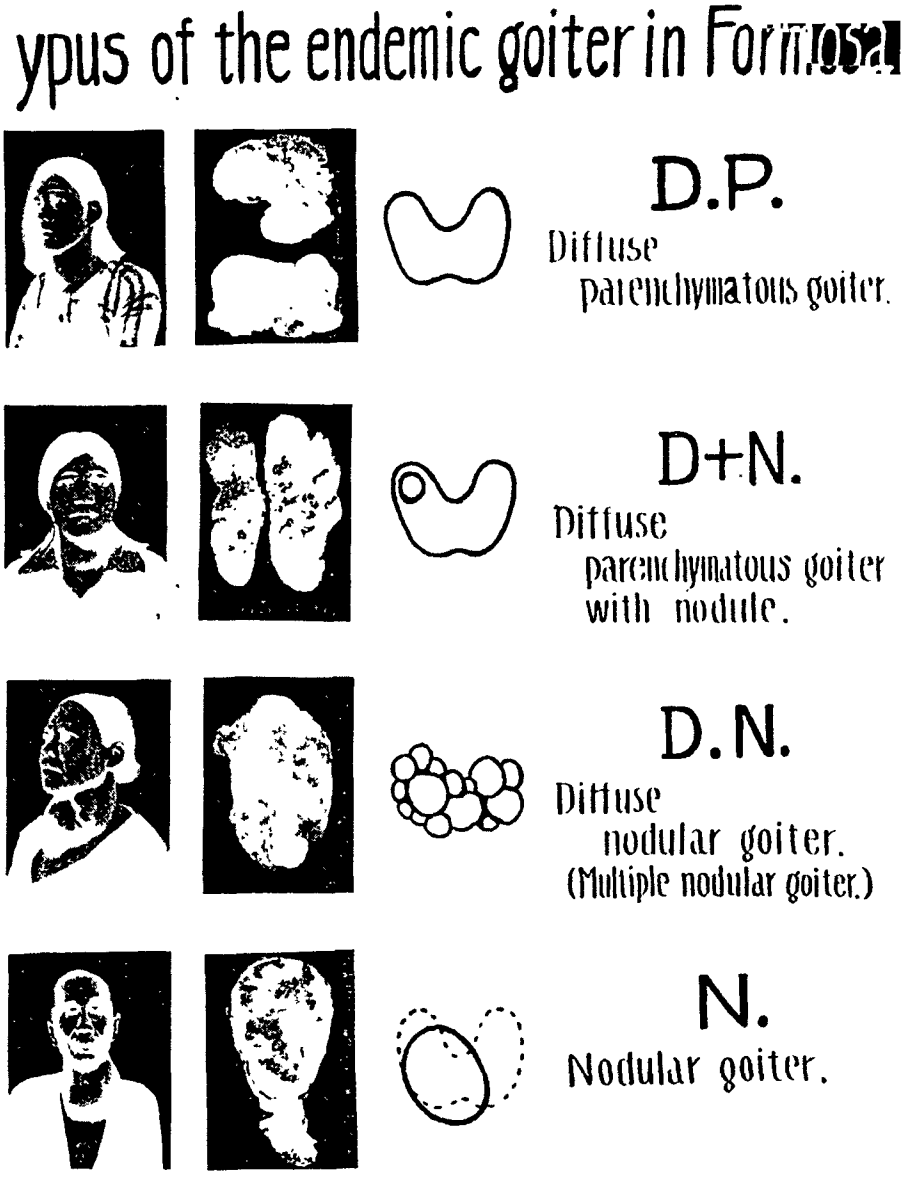


PLATE I.—Showing the types of endemic goiter in Formosa.

live in the mountains, come second. There is little or no difference among the other tribes that live in the mountains.

The type of goiter also differs among the different races, the nodular type being more common among the Aborigines, while the diffuse type is more prevalent among the Formosans.

(4) *Relation of Goiter to Sex* (Tables III, IV and VII).—As in the other countries, goiter affects the female more than the male. The female to male ratio is between 1 :45 in Formosa. The rate of incidence in the different sexes depends on the endemicity of goiter and age. The higher the endemicity, the greater the proportion of males affected. The seacoast districts have the lowest ratio because of their low endemicity. The ratio varies with age (Table VII) ; in childhood, this ratio is low, but it increases with age, because the females are affected in larger numbers. It reaches its maximum of 5.7 per cent (Aborigines) and 7.7 per cent (Formosans) at 40 to 50 years of age, after which it decreases.

(5) *Relation Between Age and Goiter* (Tables VII, VIII and IX).—Goiters are found among all ages in the endemic regions, and have been observed in an 11-month-old infant, to a 90-year-old female. Congenital goiter has never been seen in Formosa.

Table VIII represents the rate of incidence in each five-year period of 14,548 cases observed among a population of 43,576. The highest percentage of goiters is found in the prepuberty period of ten to 14 years. It decreases very gradually in the female, but in the male it decreases very rapidly until 20 to 25 years of age. After that, both sexes show almost the same rate of decrease. Such decrease in the rate after puberty depends on the endemicity —the lower the endemicity, the more rapid the decrease. The highest incidence of goiter is in the puberty period of 14 to 20 years—which corresponds to the universal, true incidence of goiter throughout the world. The difference of race has no effect whatsoever.

C. Clinical Classification.—(1) *Morphologic Classification and Course of Development*: From our survey of 14,345 cases, we prefer to classify the endemic goiter of Formosa into the following four types (Plate I): (1) Diffuse parenchymatous goiter (DP). (2) Diffuse parenchymatous goiter with nodules (DN). (3) Nodular goiter (N). (4) Diffuse nodular goiter (DN). Each type is represented in Plate I. Under parenchymatous goiter, the colloid and the follicular types are included, since they are often difficult to differentiate clinically. Table X represents the classification of each type. The majority, or 80.9 per cent, belong to the diffuse parenchymatous type. The nodular type, both single or multiple, is represented by 19.1 per cent. The distribution of each type depends upon the age and race. The nodular type is found in 41.6 per cent of the goiters among the Aborigines, 11.3 per cent of those of the Formosans, and in 2.1 per cent of those of the Japanese. The parenchymatous goiter is unusual among the adults of the Japanese proper and the Aborigines, but is numerous among the Formosans.

The age distribution of each type is represented in Tables XI and XII; the race distribution is also shown in Table X. The diffuse parenchymatous goiter reaches its greatest incidence at 12 years of age and then rapidly decreases. On the other hand, nodular goiter increases with age (Table XI). The former may be designated as the goiter of childhood and young people, and the latter the goiter of middle life and older people.

The following conclusions have been reached in regard to the development of each type: Endemic goiters develop mostly as the diffuse parenchymatous type and may remain as such or may progress into the diffuse parenchymatous goiter with nodule and may further develop into diffuse nodular goiter. It may develop, on the other hand, as a nodular type from the beginning and

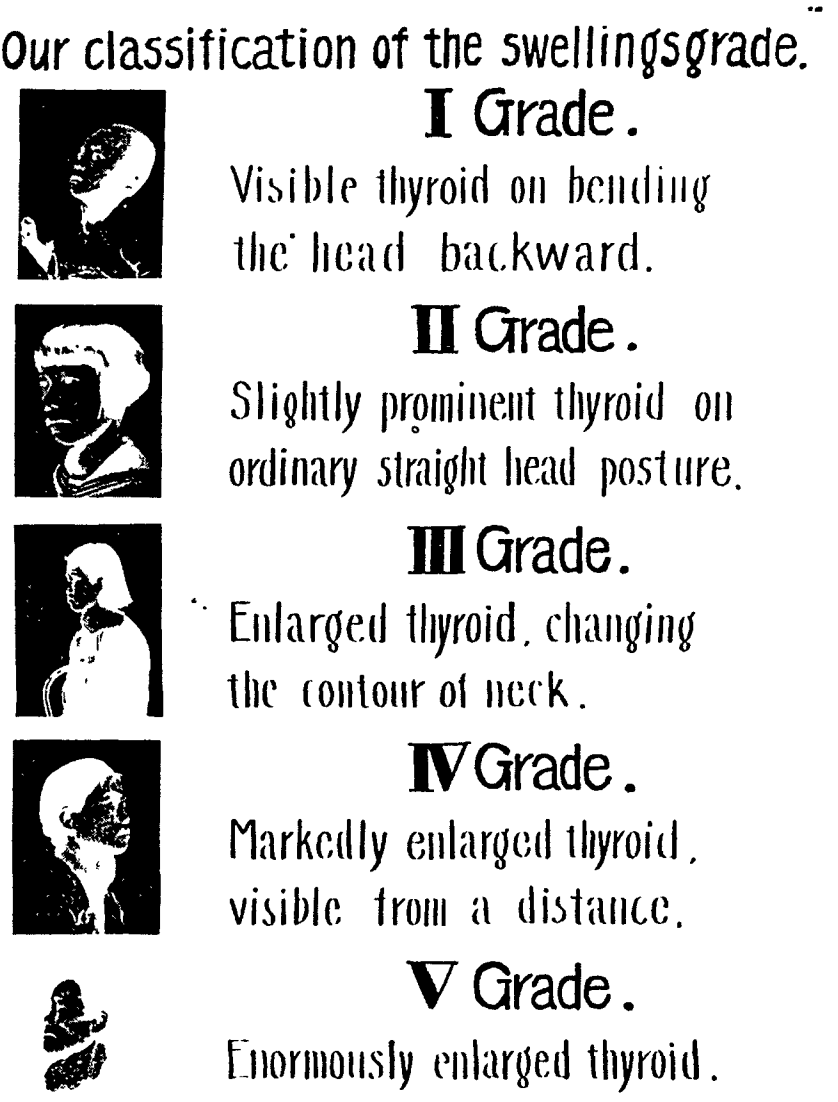


PLATE II.—Showing the authors' classification into grades according to the degrees of swelling of the thyroid gland.

remain as such and enlarge or transform into a diffuse nodular goiter (Table XIII). Therefore, larger goiters are much more common in the older people, and usually the nodular or diffuse nodular types are the more prevalent.

Size (Plate II).—We have classified the different goiters into five grades according to the modified scale of Dieterle. The grades of swelling are related

TABLE X

Classification According to Types.

Number of Goiters. 14345.

Race	Sex	D. P.		D + N		D.N.		N.		Total	
Japanese Proper	♂	45	97.8%					1	2.2%	46	100.0%
	♀	95	97.9%					2	2.1%	97	"
	Total	140	97.9%					3	2.1%	143	"
Formosans	♂	3288	91.5%	76	2.1%	30	0.8%	199	5.5%	3593	"
	♀	5985	87.3%	309	4.5%	132	1.9%	424	6.1%	6850	"
	Total	9273	88.7%	385	3.6%	162	1.5%	623	5.9%	10443	"
Aborigines	♂	802	73.9%	57	5.2%	6	0.5%	219	20.2%	1084	"
	♀	1394	52.1%	413	15.4%	109	4.0%	759	28.3%	2675	"
	Total	2196	58.4%	470	12.5%	115	3.0%	978	26.0%	3759	"
Total	♂	4135	87.5%	133	2.8%	36	0.7%	419	8.8%	4723	"
	♀										

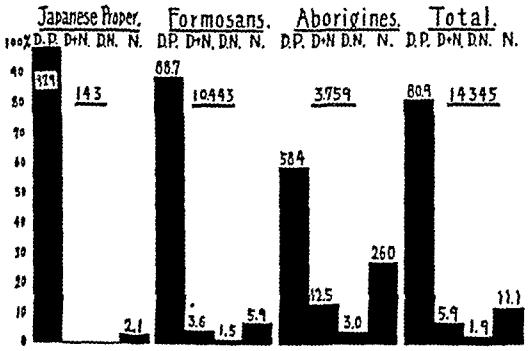


TABLE XI

Distribution According to Age of Each Type.

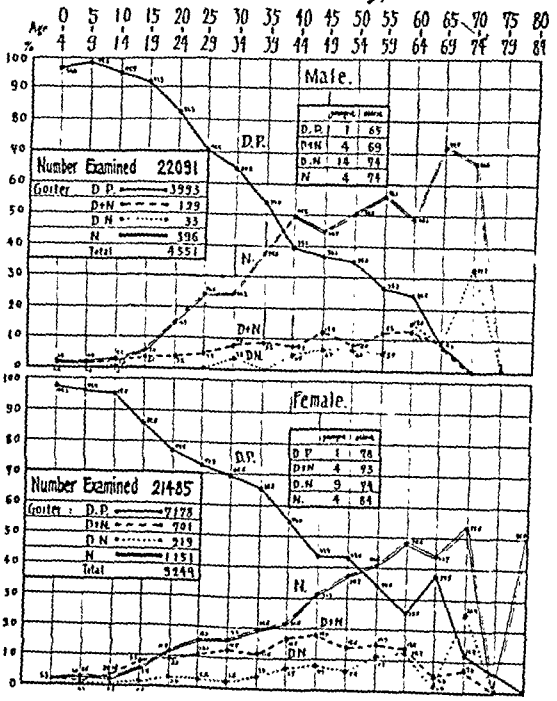


TABLE XII

Number of Goiter-types According to Age.

13,866 Goiters.

Types. \ Age.	0—90	10—90	20—90	30—90	40—90	50—90
Diffus goiter	80.9%	79.7%	60.9%	51.3%	39.8%	32.7%
Nodular goiter	19.1%	25.3%	39.6%	48.7%	60.2%	67.3%

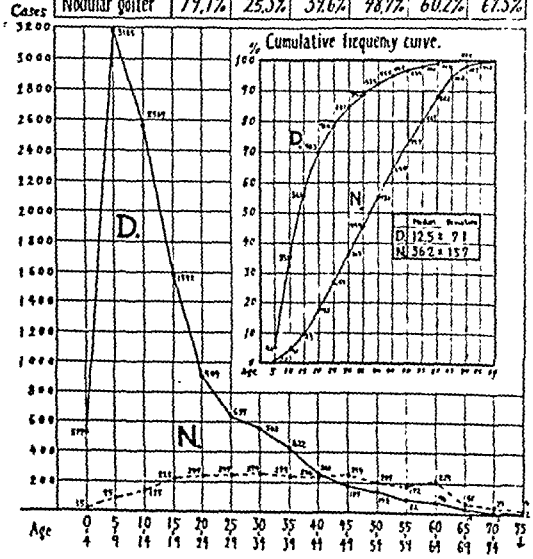


TABLE XIII

Development of the endemic goiter.

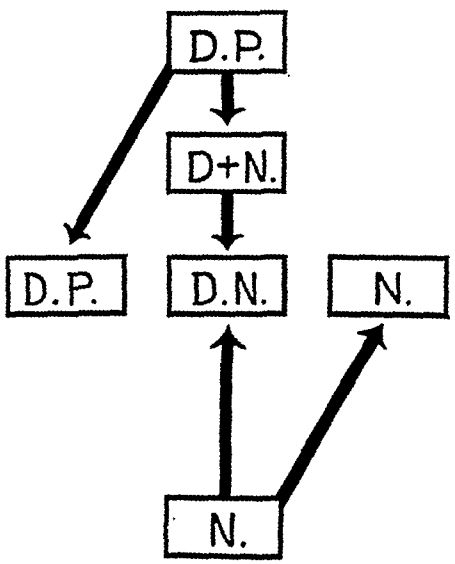


TABLE XIV

Classification Based on Swelling.

Number of Goiters: 14,683.

Race	Sex	I.		II.		III.		IV.		V.		Total	
Japanese Proper.	♂	42	91.3%	3	6.5%			1	2.2%			46	100%
	♀	79	81.4%	17	17.5%			1	1.1%			97	"
	Total	121	84.6%	20	13.9%			2	1.5%			143	"
Formosans	♂	3045	80.2%	648	17.0%	88	2.3%	9	0.2%	3	0.1%	3994	"
	♀	4331	62.4%	2037	29.3%	472	6.8%	65	0.9%	31	0.4%	6936	"
	Total	7377	68.7%	2685	25.0%	560	5.2%	74	0.6%	34	0.3%	10730	"
Aborigines	♂	781	70.3%	261	23.5%	46	4.1%	16	1.4%	6	0.5%	1110	"
	♀	1179	43.6%	907	33.5%	394	14.5%	154	5.7%	66	2.4%	2700	"
	Total	1960	51.4%	1168	30.6%	440	11.5%	170	4.4%	72	1.8%	3810	"
Total.	♂	3868	78.1%	912	18.4%	134	2.7%	26	0.5%	9	0.1%	4950	"
	♀	5589	57.4%	3051	31.3%	866	8.8%	220	2.2%	97	0.9%	9733	"
	Total	9458	64.4%	3873	26.9%	1000	6.8%	246	1.6%	106	0.7%	14683	"

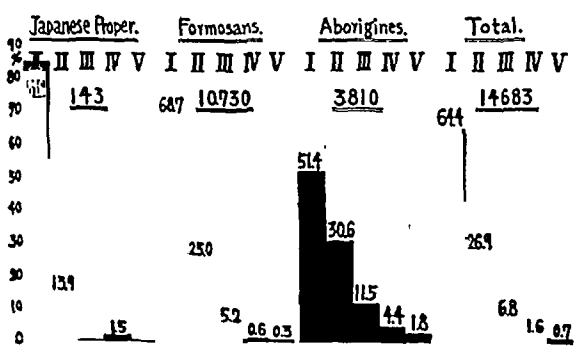


TABLE XV

Number of Goiters According to the Different Grades of Swelling and its Distribution as to Age.

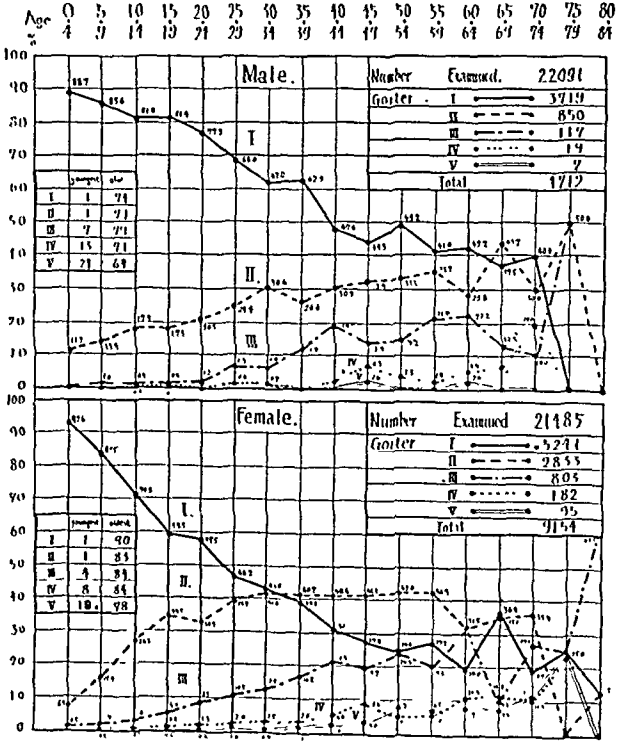
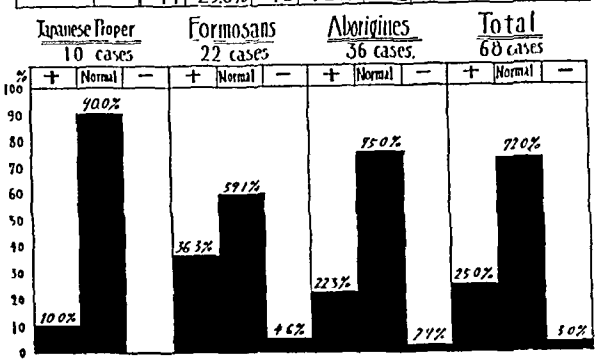


TABLE XVI

Classification Based on Basal-metabolism.

Number of Goiters: 68 cases.

Race	Sex	elevated		normal		reduced		Total	
Japanese Proper.	♂								
	♀	1	10.0%	9	90.0%	0		10	100.0%
	Total	1	10.0%	9	90.0%	0		10	"
Formosans	♂								
	♀	8	36.3%	13	59.1%	1	4.6%	22	"
	Total	8	36.3%	13	59.1%	1	4.6%	22	"
Aborigines	♂	1	25.0%	2	50.0%	1	25.0%	4	"
	♀	7	21.9%	25	78.1%	0		32	"
	Total	8	22.3%	27	75.0%	1	2.7%	36	"
Total	♂	1	25.0%	2	50.0%	1	25.0%	4	"
	♀	16	25.1%	47	73.4%	1	1.5%	64	"
	Total	17	25.0%	49	72.0%	2	3.0%	68	"



also to the goiter type. Grades I and II are diffuse parenchymatous type which are mostly found in the prepuberty period. The nodular goiters are found also in the childhood period, but they also commonly develop after puberty and enlarge in size with the age. Table XIV represents the number and percentage of each grade. Table XV shows the relation between different grades of swelling and the age.

(2) *Classification Based on Function.*—According to the examination performed on 68 cases, the basal metabolism is elevated in 25 per cent of all cases. On the other hand, 3 per cent of all cases are reduced (Table XVI).

TABLE XVII

Classification Based on Functional Effect Produced on the Visceral Nervous System.

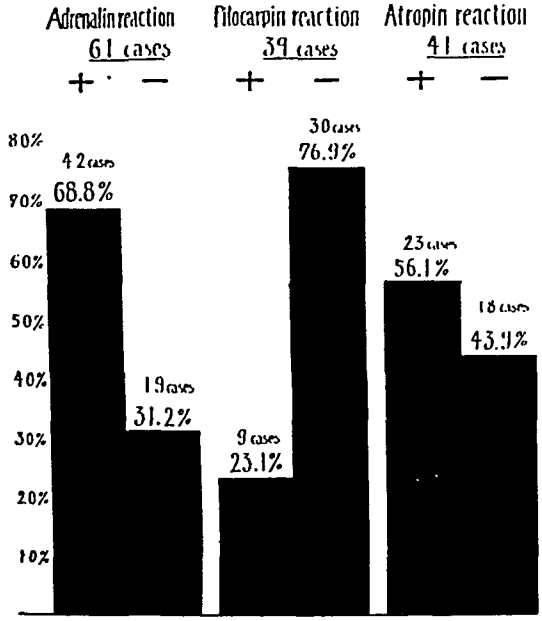
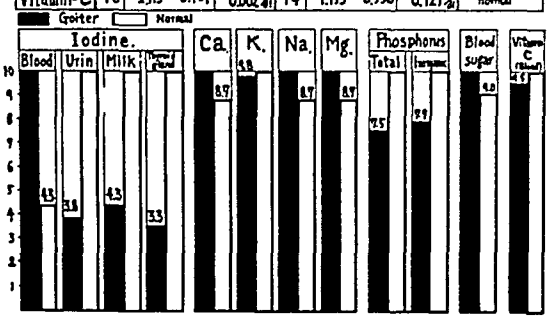


TABLE XVIII

Mineral Metabolism

Bloodsugar and Vitamine.

		Goiters.			Normal.			
		Number of Cases	Max.–Min.	Mean	Number of Cases	Max.–Min.	Mean	
J.	Blood	41	231.65–19.035	63.032 γ%	32	42.30–12.69	27.573 γ%	Increased
	Urin	15	3302.84–57.105	309.446 γ	15	331.13–23.88	89.445 γ	decreased
	Milk	5	31.71–8.46	16.802 γ%	7	48.65–25.38	38.992 γ%	"
	Thyroid gland	29	18.50–0.199	3.518 γ		17.77–4.613	10.581 γ	"
Ca.		32	15.20–10.45	12.09 mg%	19	11.05–9.12	10.55 mg%	slightly increased
K.		32	23.04–13.30	16.73 mg%	17	19.45–16.96	17.06 mg%	about normal
K/Ca		32	1.53–0.70	1.24	17	1.95–1.48	1.74	slightly decreased
Na.		4	402.50–391.00	401.16 mg%	2	356.30–345.10	351.20 mg%	slightly increased
Mg.		4	2.79–1.96	2.63 mg%	2	2.38–2.25	2.31 mg%	"
P.	Total	36	14.07–5.42	8.64 mg%	16	15.67–8.79	11.40 mg%	decreased
	Inorganic	36	5.09–1.04	3.75 mg%	16	6.63–3.35	4.78 mg%	decreased
Bloodsugar		33	1260–84.0	97.5 mg%	6	104.0–82.0	88.0 mg%	slightly increased
Vitamin-C		16	2.115–0.901	0.882 mg%	14	1.183–0.536	0.927 mg%	about normal



Cretinoid cases, such as are seen in Switzerland, are not frequently encountered. In the highly endemic regions, the Basedow's disease types are not found. However, in 36.3 per cent of the Formosans operated upon, the basal metabolic rates were high. On the other hand, the Japanese proper and the Formosans, in the practically nonendemic regions of Formosa, have the tendency of developing the Basedow type of disease.

According to the function of the vegetative nervous system, relative sympaticopathy is encountered in one-half of the cases (Table XVII).

D. Pathologic Physiology.—We have examined the iodine, mineral, sugar and vitamin metabolism of goiter cases.

(1) *Iodine Metabolism* (Table XVIII).—The blood iodine of goiter cases, estimated by Fellenberg's method, increases in many cases about twice that of normal. The mean value in goiter cases is 63.032 micrograms per 100 cc. in comparison to the normal cases of 27.573 micrograms per 100 cc. But

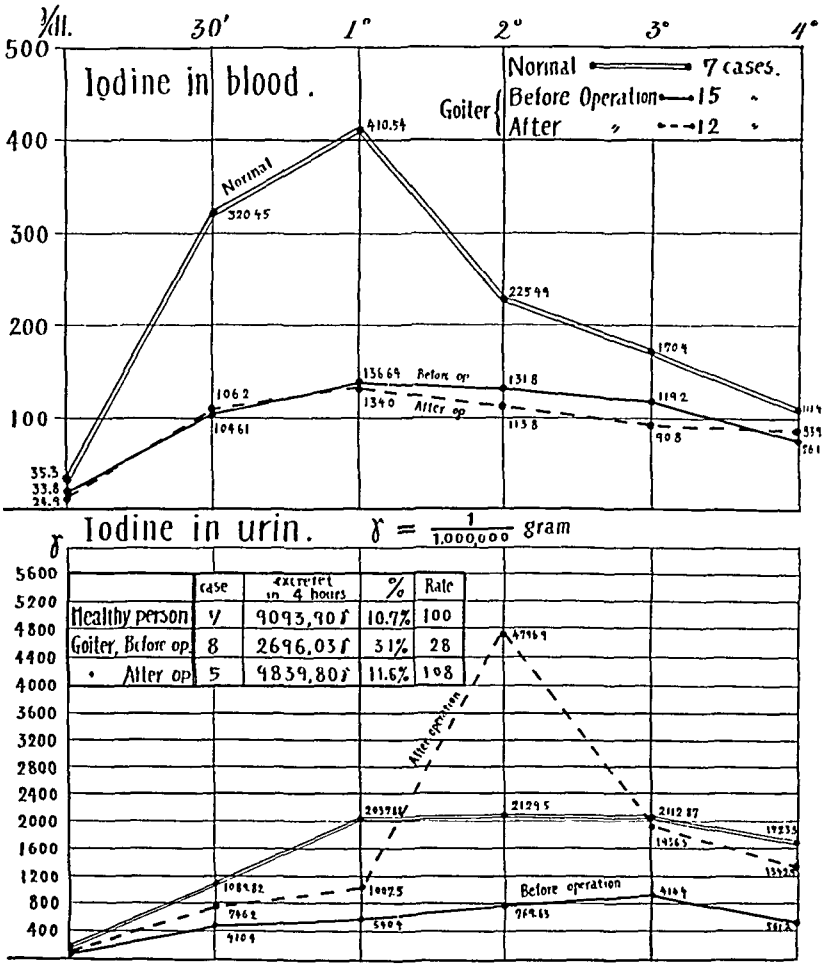
this finding does not agree with that in the other countries. The iodine contents of the blood are high in healthy Formosans.

The excretion of iodine in the urine during 24 hours is less in cases of goiter—309.446 micrograms per day. In the normal the excretion is 809.445 micrograms per day. Likewise, the excretion of iodine in milk is also

TABLE XIX

Loading test with Iodine.

84,500 γ oral. (0.1 gram K.J. + 100 c.c. H_2O)



less than the normal. The content of iodine in extirpated goiter tissues is less than that from healthy glands, notwithstanding its larger volume in weight.

Loading the blood with iodine, by means of giving 0.1 Gm. of KI. with 100 cc. of water, shows that in the goitrous patient the blood iodine increase is less than in healthy persons (Table XIX) before and even after

operations. Likewise the excretion of iodine in the urine for four hours is less, 3.1 per cent, compared with 10.7 per cent in the normal individual. However, it returns to the normal value of 10.7 to 11.6 per cent after resection of the goiter.

(2) *Mineral Metabolism* (Table XVIII).—We have estimated the calcium, potassium, magnesium, sodium, and phosphorus in the blood of goiter cases and healthy persons. The calcium content of the blood increases slightly; the mean value is 12.09 mg./dl., the normal being 10.55 mg./dl.

The magnesium and sodium contents of the blood in the goiter patients also increase a little. The potassium in the blood shows almost a normal value in most cases, thus, the Ca/K index decreases a little. Both inorganic and organic phosphorus in the blood decrease slightly.

(3) *Sugar and Vitamin Metabolism* (Table XVIII).—We have not encountered any hyperglycemia in goiter cases. The blood sugar remained within the normal upper limit. The adrenalin glycemia is depressed in one-half of the cases, although the accelerated and normal cases are about the same. This adrenalin glycemia reaction does not parallel the adrenalin pulse and blood pressure reaction, the basal metabolism, and the execretory function of the liver tested with dye. The double sugar-loading test shows no special findings. There is a disturbance of liver function in one-half of all cases by the azorubin test. On the other hand, the function of the kidney is normal from the standpoint of the dye test. The vitamin C content of the blood is lower than normal.

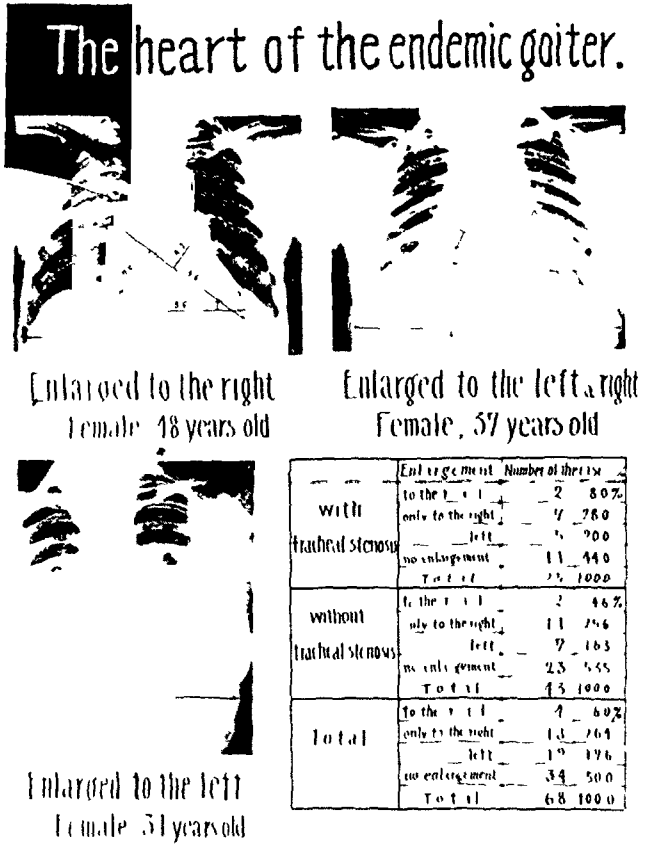
(4) *Stenosis and Dislocation of the Trachea* (Plate III).—For this study, roentgenograms were taken in 68 cases. Tracheal stenosis were found in 38.1 per cent of them. They occur not only in cases of large nodular goiter but also in instances of the Grade III, diffuse parenchymatous goiter. The stenoses are either circular or saber-form. The dislocation of trachea takes place either from the side or behind, and the distance of the trachea from the vertebrae increased. Dyspnea occurred not infrequently.

(5) *Goiter Heart* (Plate IV).—The hearts of the goiter patients are found to be enlarged in one-half the cases. The right-sided enlargement is much more frequent than the left (26.4 to 17.6 per cent). Bilateral enlargement is found in only 6 per cent of cases. The heart enlargement has no relation to the tracheal stenosis.

SUMMARY

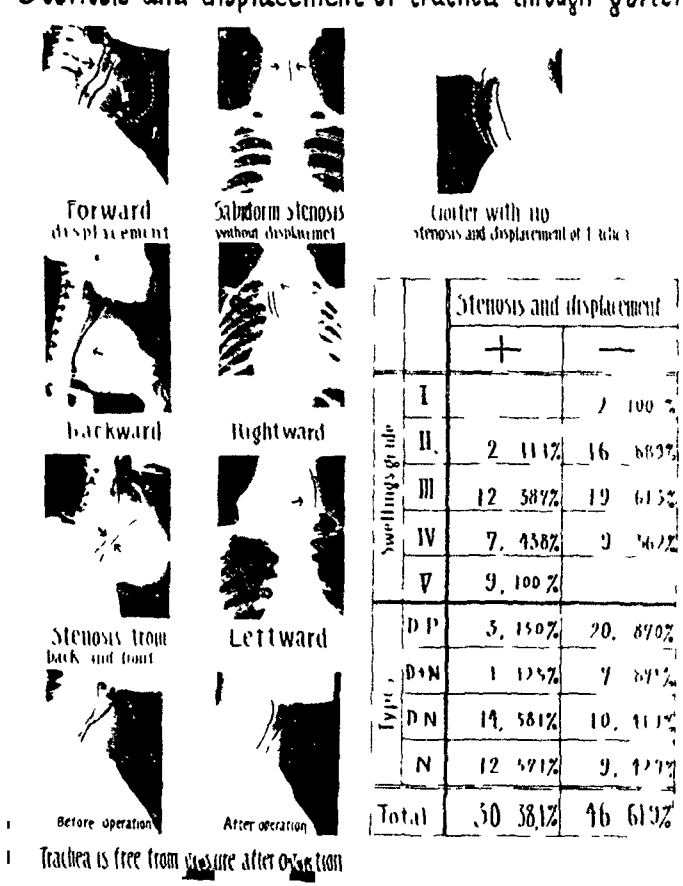
In Japan proper, only sporadic goiters are encountered. Endemic goiters are found only in Formosa. The highest rate in one region in Formosa is 63.5 per cent, in which rate of incidence, 78.8 per cent occur in females, when only the female population is considered.

The Japanese proper in Formosa are less frequently involved; the Formosans come second; and the Aborigines are the most susceptible. The low endemicity among the Japanese proper is accounted for by the fact that seafoods are eaten more generally by them. Nodular goiters are prevalent among



	Enlargement	Number of the case	
with tracheal stenosis	to the left + right	2	80%
	only to the right	7	280
	left	5	200
	no enlargement	11	440
	Total	25	1000
without tracheal stenosis	to the left + right	2	46%
	only to the right	11	256
	left	7	163
	no enlargement	23	535
	Total	43	1000
Total	to the left + right	4	60%
	only to the right	18	264
	left	12	176
	no enlargement	34	500
	Total	68	1000

PLATE III.—Roentgenograms showing the various types of stenoses encountered, and the degrees of displacement of the trachea.



		Stenosis and displacement	
		+	−
Swellings of the	I		7 100 %
	II	2 11.1%	16 88.9%
	III	12 38.7%	19 61.3%
	IV	7. 43.8%	9 56.2%
	V	9. 100 %	
Types	D P	5. 19.2%	20. 80.8%
	D N	1 12.5%	7 87.5%
	D N	14. 58.1%	10. 41.9%
	N	12 57.1%	9. 42.9%
Total		30 38.1%	46 61.9%

PLATE IV.—Roentgenograms showing the various degrees and direction of enlargement of the heart, and their relevant measurements.

the Aborigines, while the parenchymatous goiters are more common among the Formosans. The basal metabolic rate is increased in about 25 per cent of the cases. The iodine content of the blood is high.

REFERENCES

[1] Papellier, E.: Warum gibt es in Japan keinen Kropf? Wien. med. Wchnschr., **88**, Nos. 28–29, 801, 1938.

[2] McClendon, J. F.: Der Kropf in Japan. München. med. Wchnschr., **82**, No. 23, 901, 1935.

[3] McClendon, J. F., and Itami, J.: Iodine and Goiter with Special Reference to the Far East. Jour. Biol. Chem., **102**, 91, 1933.

[4] Aschoff, L.: Zur Kropffrage in Japan, Eine Reisebemerkung. Virchows Arch., **254**, 841, 1925.

Idem: Über das Vorkommen der Basedow-Schilddruse in Japan. München. med. Wchnschr., **81**, No. 24, 902, 1934.

[5] Okano, Y.: Statistical Observation of Simple Goiter and Basedow's Disease. Japanese Jour. Int. Med. (Nippon Naika Gakkai Zasshi), **10**, 572, 1922.

SURGERY OF THE THYROID IN A LARGE MUNICIPAL HOSPITAL

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THE PRESENT COMMUNICATION is a study of 360 consecutive cases of thyroid disease treated surgically by members of the Staff of the First Surgical Division, Bellevue Hospital, N. Y. This is one of four surgical divisions in a large municipal hospital of 2,400 beds. The analysis of this consecutive series comprises a ten-year period, from 1930 to 1939, inclusive. Our interest in surgery of the thyroid was stimulated in 1930, when a Thyroid Clinic was established by the authors in our Out-Patient Department. In going over our records it was found that during the preceding ten-year period, 1920 to 1929 inclusive, only 48 patients had been operated upon for disease of the thyroid. During the first year after the establishment of this special clinic, 100 thyroid operations were performed by our staff.

It was said, at that time, that it might be impossible for good surgery of the thyroid to be performed on the general surgical wards of a large municipal hospital. This group of cases has not had the advantages of quiet afforded by small private rooms but have been taken care of in the noisy and busy public wards. They have not had the advantages of special dietary control with measurement of caloric intake. The diet is the Bellevue high caloric diet with extras. Only a very few patients had the services of special nurses.

Due to the great physical distances at Bellevue, it proved impractical to have the close cooperation of the Medical Service, which has been so much stressed by other authors. Our patients, in the great majority of instances, were admitted directly from the Thyroid Clinic to the surgical wards, where their preoperative management was undertaken. The advantages of this plan which was forced upon us, we believe, far outweigh the disadvantages. The patients become accustomed to their surroundings, they get to know the nurses and the doctors, and the latter have the great advantage of seeing the patients daily and are in a better position to evaluate the severity of the disease and the progress the patient is making. Needless to say, medical and other consultations are frequent when the thyroid conditions are associated with such complications as heart failure, pregnancy, diabetes, *etc.*

Naturally, hyperthyroidism is the thyroid condition we are most interested in. Table I shows the distribution of the cases of thyroid disease.

The great majority of our cases were first seen by one or both of the authors in the Thyroid Clinic or on the surgical wards, and their preoperative management was supervised by us. The evaluation of the severity of the hyperthyroidism was made when the patients first appeared in the Thyroid

* Read before the New York Surgical Society, November 22, 1939. Submitted for publication November 3, 1939.

Clinic, and, at this time, it was determined as to whether a one-stage or a two-stage operation was to be performed. We feel that this early decision as to his real condition should be made when the patient is carrying on his normal activities. This is vitally important. An excellent example of how bedrest alone can mask a severe underlying hyperthyroidism is shown by the following case:

TABLE I

DISTRIBUTION OF ALL CASES OF THYROID DISEASE
(1930–1939)

Goiter:			
	Toxic Cases:	Exophthalmic goiter.....	175
		Toxic adenomata.....	70
			245
	Nontoxic Cases:	Adenomata.....	115
		Total	360

Case Report.—A young girl, age 22, had been referred by another hospital, direct to our wards, as a case of borderline hyperthyroidism. She had been in bed in this hospital for one month, and remained in bed on our wards for another two weeks. She was seen in consultation by a physician with large experience in hyperthyroidism, who made a diagnosis of neurocirculatory asthenia and who advised no operation and discharge to the Psychiatric Clinic. Three days after discharge, the patient returned to our wards to visit a friend and happened to be seen by one of us. She was on the verge of a thyroid crisis, with a pulse rate of 180.

Eleven members of our staff operated upon the cases in this series, independently. To offset the disadvantages of this, a strict regimen was carried out suitable to our service. First, a decision had been reached as to whether or not the patient should be operated upon in two stages. We deplore the custom, adopted on some services, where a decision as to employment of a one- or two-stage procedure is left to the anesthetist at the time of operation. In the Thyroid Clinic, the patient is subjected to the following: Basal metabolic rate; electrocardiogram; exophthalmetric measurements; anterior and lateral roentgenograms of the trachea, for deviation and compression; and examination of the vocal cords. On admission to the surgical wards, the patient is kept at bedrest for a few days and then allowed to be up one hour a day. Lugol's solution, minims 10, t.i.d., and luminal, grains 1, t.i.d., are given. Forced fluids and a high caloric diet are instituted. One basal metabolic determination is made preoperatively, and any gain of weight is determined. More rapid improvement on this regimen than was expected, however, never leads us to reverse our decision from a two-stage to a one-stage procedure. However, if the patient's condition is poorer than we had anticipated, or is complicated by an intervening acute infection, we frequently decide on two stages, rather than the original one-stage.

On analyzing the 175 cases of exophthalmic goiter, we found that most of

the patients were women, that most of them fell in the third and fourth decades, and that approximately 20 per cent were over 45 years of age. The average age was 34.5 years. This is lower than in the cases of toxic adenomata, which averaged 41.8 years. We found a higher proportion of colored people than we expected, 13, or 7.5 per cent. The duration of symptoms among this group was 16.6 months, whereas in the toxic adenoma cases it was 57 months. These patients were hard working people in the lower economic groups and frequently put off seeking medical attention until the last possible moment. We found, however, that the patients suffering from hyperthyroidism in our clinic were considerably above the average type of the very poor Bellevue patient.

TABLE II

ANALYSIS OF CASES OF THYROID DISEASE

	175 Cases Exophthalmic Goiter	70 Cases Toxic Adenoma	115 Cases Nontoxic Adenoma
Sex: Female	138	64	102
Male	37	6	13
Average age	34.5 yrs.	41.8 yrs.	36 yrs.
Colored	13	2	0
Duration of test symptoms	1.3 yrs.	4.8 yrs.	9.7 yrs.
Average loss of weight	25.3 lbs.	20 lbs.	none
Diarrhea	39	1	none
Previous operations	15—8.5%	5—7.1%	1
Previous roentgen ray therapy	3	1	0
Previous iodine therapy	27	9	8

In going over the possible etiologic factors concerned with the onset of hyperthyroidism, we cannot refrain from mentioning the danger of general or interval surgery in patients suffering from hyperthyroidism, before the condition is controlled by thyroidectomy. The authors were able to collect a series of cases in which such procedures as cholecystectomy, removal of rectal polypi, tonsillectomy, extracting teeth, *etc.*, were carried out in persons suffering from hyperthyroidism, with an operative mortality of 30 per cent.

We find that 39, or 22.2 per cent, of the patients suffered from diarrhea. The average loss of weight in 151 cases is 25.3 pounds. Approximately 20 per cent of these lost from 45 to 50 pounds.

We were interested in the fact that 15, or 8.5 per cent, of our exophthalmic group, and five, or 7.1 per cent, of our toxic adenoma group had had previous operations elsewhere, and the majority of them at well known thyroid clinics. We find many of them well for from five to 13 years following their original operation, before recurrence of symptoms. This has impressed us with the importance of long follow-up examinations in this type of patient following operation, and the danger of considering a case cured without adequate follow-up.

Previous roentgenotherapy had been administered in only four of all the

toxic cases, but in one patient it was undoubtedly one of the contributing factors in her postoperative death.

Previous iodine therapy was noted in 14 per cent of our toxic patients. In two cases there was evidence of the patient being "iodine-fast":

Case 1.—The first patient, a young woman physician who had recurrent hyperthyroidism, had been given small doses of iodine for a period of three years. Following operation for removal of rectal polypi, under prolonged anesthesia, the patient went into a severe thyroid crisis and at no time before her thyroidectomy were we able to control her with iodine. She, however, recovered following thyroidectomy.

Case 2.—The second patient was a female, age 35, who had been taking iodine for eight weeks previous to admission. She could not be controlled with iodine, and died in thyroid crisis, following operation.

We find that in this group, 80, or 45.7 per cent, of our patients had exophthalmos at the first examination. This determination is based on actual measurements of the eyes with the exophthalmometer, which gives an accurate idea of the degrees of exophthalmos and does away with the inaccurate impressions gained from the various text-book eye signs. It also gives an accurate evaluation of whether this condition improves or progresses following operation. More will be said concerning this condition in the analysis of our follow-up report. The average measurements were O.D. +20.9; O.S. +20.9.

The average blood pressure readings in the exophthalmic group were: Systolic, 140 Mm. of mercury; diastolic, 73, with a pulse pressure of 67. The readings in the toxic adenoma group were approximately the same.

Systolic murmurs were noted at the apex in 147 out of 245 patients. We do not believe that these murmurs were evidence of organic heart disease but relative mitral insufficiency due to an overacting heart. The great majority of murmurs disappeared after the arrest of the hyperthyroidism by operation.

Auricular fibrillation occurred preoperatively in 15 of the toxic patients, and in only two did it fail to disappear following thyroidectomy.

TABLE III

	175 Cases Exophthalmic Goiter	70 Cases Toxic Adenoma
Exophthalmos	80—45.7%	0
Blood pressure	140/73	147/82
Pulse pressure	67	65
Systolic murmur, apex	107	40
Heart enlarged	101	35
Auricular fibrillation	11	4
Basal metabolic rate:		
Admission	+51.9	+36.5
Ante-operative	+24.0	+20.9
Postoperative	+ 4.4	+ 7.4
Pulse rate:		
Admission	118	109
Ante-operative	84	84
Postoperative	84	84

The average basal metabolic readings in the exophthalmic group were: On admission, plus 51.9 per cent; before operation, plus 24 per cent; and postoperatively, plus 4.4 per cent. The basal metabolic figures in this group, before treatment was instituted, were somewhat higher than similar figures of the toxic adenoma group, which were plus 36.5 per cent (Table III).

The most severe complication we encountered was that of severe tonsillitis in very toxic cases. The majority of our patients have both diseased tonsils and bad teeth. Before the introduction of sulfanilamide, their treatment necessitated prolonged bedrests. It was also responsible for the decision that a two-stage procedure would be safer. This complication was the immediate cause of preoperative crises and one of our postoperative deaths. Eight patients having rheumatic heart disease were successfully operated upon (Table IV).

TABLE IV

	175 Cases Exophthalmic Goiter	70 Cases Toxic Adenoma
Complications:		
Severe tonsillitis	10	0
Rheumatic heart disease	7	1
Hypertensive heart disease	2	2
Diabetes	4	2
Pregnancy	3	0
Rheumatic fever	1	1
Pulmonary tuberculosis	1	1
Operations:		
Partial thyroidectomy: One-stage	127	70
Two-stage	47	1
Ligation superior thyroid arteries	1	0

The average pulse rate on admission was 112; just before operation it was 84; and on discharge 84.

All of our toxic patients, except two, had preoperative iodine administered. These patients were mistakenly thought to have nontoxic adenomata, and Lugol's solution was not given. Both were actually toxic and had severe postoperative reactions.

Eleven surgeons performed 293 operations on 245 patients suffering from hyperthyroidism, with four deaths, a mortality of 1.6 per cent (Table V). On September 16, 1932, on the occasion of our last death, two-stage operations were instituted, and since that time, seven years ago, we have operated upon 27.4 per cent of all our cases in stage-procedures, with no deaths. No patient suffering from hyperthyroidism has been refused operation.

Avertin and gas-oxygen anesthesia was used in 246 cases. Since the establishment of the Anesthesia Department at Bellevue, avertin and cyclopropane have been used 49 times. Local anesthesia has been employed in only nine instances. We have found avertin, as a basal anesthetic, to be highly successful, the patient arriving in the operating room oblivious of his surroundings.

Severe postoperative reactions occurred in 18 instances, or 6.1 per cent. These patients were treated by continuous infusion of glucose, ice packs, iodine, sedatives and the use of the oxygen tent.

TABLE V

MORTALITY STATISTICS

	Number	Deaths	Per Cent
Toxic Cases	245	4	1.6%
Exophthalmic goiter	175	3	1.7%
Toxic adenoma	70	1	1.4%
Nontoxic adenoma	115	0	0

Appended is an analysis of four deaths, all occurring during the first three years of this series:

ANALYSIS OF POSTOPERATIVE DEATHS

Case 1.—B. W., white, male, age 43, Jewish, was admitted to the hospital, July 16, 1931, and died July 29, 1931. His chief complaints were nervousness, palpitation, loss of 30 pounds of weight in five months. A diagnosis of exophthalmic goiter was made. His B.M.R. was plus 55. He was put on iodine medication for 13 days; a subtotal thyroidectomy was performed under avertin and gas-oxygen anesthesia. His pulse never went over 110 during the operation, and his condition was considered excellent. However, the patient died 12 hours later in a thyroid crisis. This is the moderately severe type of thyroid case that we now operate upon in two stages.

It was poor surgical judgment to have operated upon this man in one stage. We might bring up, in connection with this case, the danger of leaving to the anesthetist the decision as to whether both lobes should be removed at one operation. After removing this patient's right lobe and isthmus, his condition was excellent, yet it is obvious that we should have terminated the operation at that time.

Case 2.—C. J., female, age 30, Colored, was admitted to the hospital, March 9, 1932, and died April 17, 1932. Her chief complaints were nervousness, palpitation, sweating, and loss of 50 pounds of weight in one year. She was an extremely sick exophthalmic goiter case, with a B.M.R. of plus 58. Her exophthalmos measured O.D. plus 21; O.S. plus 21. On the twelfth day following admission, she developed a severe hemolytic streptococcus tonsillitis. Unfortunately, iodine medication was then withdrawn for nine days. On her twenty-fifth day, she went into a thyroid crisis with delirium. She improved with the usual treatment but, on the thirty-sixth day, she was thought to be losing ground, there was no response to iodine so that both superior thyroid arteries were ligated under local anesthetic. This was undertaken in her own bed. She died 24 hours later, in a thyroid crisis.

Obviously iodine should not have been withdrawn just when she needed it most. It was a desperate cause, but we still think that ligation of the arteries was justified.

Case 3.—A. C., female, age 35, was admitted to the hospital, August 31, 1932, and died September 16, 1932. Her chief complaints were nervousness, palpitation, and loss of 50 pounds of weight in two years. She was an extremely ill case of exophthalmic

goiter, with a B.M.R. of plus 94. She had been taking iodine for eight weeks but had discontinued it one month before admission. It was impossible to control this patient with iodine; her weight dropped from 96 to 79 pounds. In spite of this she was operated upon, 16 days after admission. Following removal of the right lobe the patient went into extremis and died after several hours.

Death in this case was due to poor surgical judgment. She was obviously iodine-fast, and should have had prolonged bedrest followed by preliminary lobe ligations.

Case 4.—M. C., female, age 51, was admitted to the hospital, May 4, 1932, and died May 16, 1932. Her chief complaints were goiter, cough, and dysphagia, for 18 years; large veins on the neck and chest for four years, and nervousness for three years. She had been treated in the Medical Department for three years, during which time she had roentgen ray treatments. Her B.M.R. was plus 37. The diagnosis was hyperthyroidism, associated with an enormous intrathoracic adenoma, causing obstruction of the trachea, and the superior vena cava. She weighed 85 pounds. Following ten days of iodine therapy, an extremely large intrathoracic goiter was removed under avertin, and local anesthesia. She did well for 24 hours, and then died in a delayed thyroid crisis.

We believe that if operation could have been performed three years earlier, and before roentgenotherapy was instituted, the patient might have had a better chance of survival.

Mild infections occurred in 25 instances, and included wounds showing but one drop of pus—the offending organism was usually *Staphylococcus aureus*. Severe infection occurred four times—the organisms recovered were hemolytic streptococcus twice and colon bacillus twice. Catgut was used in all operations but two. All but two wounds were drained. The incidence, then, of postoperative wound infection in 408 operations was 7 per cent.

Postoperative hemorrhage occurred seven times, or 1.7 per cent. All patients were reoperated upon on the same day, and the bleeding controlled. All these patients recovered. One case required tracheotomy and developed bilateral, massive atelectases.

Small hematomata developed in 22 wounds and were evacuated. Three large hematomata, from slow oozing, developed and caused tracheal obstruction. These were evacuated, causing relief of the obstructive symptoms.

The trachea was inadvertently opened in three of 413 operations. All were repaired immediately. No wound infections resulted in any case. One trachea fistula closed spontaneously one month later. It had never communicated externally.

Injury to one of the laryngeal nerves occurred seven times, or 1.7 per cent. One patient was hoarse for one year, one for six months, and three cleared up before leaving the hospital. One patient is still hoarse, after three years; the others all have normal speaking voices. In two cases, one nerve had been injured during a previous operation elsewhere, and following further operation, developed temporary bilateral cord paralyses. Both cases had intratracheal catheters introduced, one for 24 hours, and the other for 48 hours. Fortunately, the recent injury proved only of a temporary nature (Table VI).

TABLE VI

POSTOPERATIVE COMPLICATIONS

	Exophthalmic Goiter	Toxic Adenoma	Nontoxic Adenoma	Totals	Per Cent	
Number of operations	222	71	115	408		
Severe reactions	16	2		18	6.1%	
Infections: Mild	18	3	4	25	6.+%	7.0%+
Severe	4	0	0	4	1.0%	
Postoperative hemorrhage	4	0	3	7	1.7%	
Hematoma: Large	2	0	1	3	0.7%	6.0%+
Small	9	6	7	22	5.6%	
Tracheal injury	3	0	0	3	0.7%	
Recurrent laryngeal nerve injury	5	1	1	7	1.7%	
Tetany: Mild	3	0	0	3	0.7%	0.9%
Severe	1	0	0	1	0.2%	
Myxedema: Mild	7	0	0	0	2.9%	

Of 360 patients operated upon for thyroid disease, 345, or 94 per cent, have been followed for from six months to ten years. All of these cases have been actually examined by one of the 11 operators, and most of them have been seen by one or both authors, in the Thyroid Clinic.

TABLE VII

FOLLOW-UP RESULTS—345 OUT OF 360 CASES—94 PER CENT

	Exophthalmic Goiter	Toxic Adenoma	Nontoxic Adenoma
Number of cases	170	66	109
Average gain in weight	22	16.6	
Average pulse pressure	85	81.7	
Average blood pressure	130/80	142/98	
Pulse pressure	50	56	
Average basal met. rate	+7	−2	
Recurrence	14—8%	1—1.4%	6—5.2%
Excellent	164—96.4%	64—96.9%	104—95.4%

The average gain in weight among the toxic group was 22 pounds. The average blood pressure in the exophthalmic group has been reduced from 140/73 to 130/80, with an accompanying fall in the pulse pressure from 67 to 50. The figures for the toxic adenoma group are not striking, probably due to the older age-group—147/82 as compared to 148/92, the pulse pressure falling from 65 to 56.

The average basal metabolic rate, for all toxic cases followed, is plus 3 per cent (Table VII).

The average exophthalmetric readings on those having exophthalmos before operation was O.D. plus 20.9; O.S. plus 20.9; these same patients in follow-up showed measurements of O.D. plus 21; O.S. plus 21. The current feeling has been, we believe, that, of those patients suffering from exoph-

thalmos associated with hyperthyroidism, at least 50 per cent get well. Our figures do not bear this out, and we feel very strongly that if accurate measurements of the eyes are taken with the exophthalmometer it will be discovered that the exophthalmos does not improve.

We have had one case of progressive exophthalmos in a female, age 21. She had a partial thyroidectomy performed for severe hyperthyroidism, and six months later was reoperated upon for persistence of symptoms. Following this, there were no hyperthyroid symptoms, but ten months later her exophthalmos increased from O.D. 25; O.S. 24, to O.D. plus 30 (well over the highest measurement on the instrument); O.S. 27. She developed marked edema of her conjunctivae but no corneal ulceration. On June 1, 1938, Dr. Joseph King performed a one-stage Naffziger operation on the right side, and on December 12, 1938, a similar operation on the left side. Her present readings are O.D. 25; O.S. 24, which are the same as before the progressive exophthalmos started.

A tarsorraphy was performed by Dr. Webb Weeks, in one case of unsightly but not progressive exophthalmos, which resulted in an excellent cosmetic result.

Recurrence or persistence of hyperthyroid symptoms following operation has occurred 15 times in 236 followed cases, or 4.2 per cent. This includes two patients in whom it recurred twice. It recurred in only one patient operated upon for toxic adenoma. Four patients, following operation, showed persistence of hyperthyroid symptoms within a very few months. We do not believe that these cases had a radical enough primary operation. Of all the recurrent and persistent cases, ten have been reoperated upon and are well, three refused reoperation, and one mild recurrence is doing well with occasional small doses of iodine (Table VII).

There have been seven occurrences of mild postoperative myxedema, an incidence of 2.9 per cent. All have been controlled by thyroid extract feedings and at their last follow-up visit were free of symptoms.

Postoperative tetany has occurred three times in a mild form and was controlled by calcium feedings. One severe case followed operation for a second recurrence. This patient had moderate to severe symptoms for six years, well controlled by calcium. At the present time there is no evidence of tetany and calcium feedings are not required.

We have one interesting case of pituitary dyscrasia in a young girl who, during 11 months previous to her operation, gained 54 pounds. She was given injections of antuitrin S., in the Endocrine Clinic, and very soon developed typical symptoms of hyperthyroidism. Following partial thyroidectomy she lost 50 pounds, and at present is normal.

Of the 236 toxic cases followed, 228, or 97.3 per cent, are classed as excellent results.

One hundred nine cases out of 115 cases of nontoxic adenoma were followed. Recurrence occurred in six cases, or 5.2 per cent. One recurrent case became toxic, with a basal metabolic rate of plus 41 and loss of 16 pounds

in weight. Five patients refused reoperation, including the toxic one. One has been reoperated upon and remained free of recurrence for four years. One hundred four out of 109 patients followed in this group are considered excellent results, or 95.4 per cent.

CONCLUSIONS

(1) That the preoperative use of iodine is a purely surgical procedure.

(2) That the postoperative regression in exophthalmos is apparent, and not real.

(3) Surgery of the thyroid can be undertaken in a large municipal hospital by a group of surgeons with a reasonably low mortality rate.

DISCUSSION.—DR. A. S. MCQUILLAN (New York) offered the suggestion that in some desperate cases the inferior thyroid vessels be ligated as well as the superior. They are larger in caliber. Doctor McQuillan has many times ligated these vessels along with the superiors and the patient has often derived more benefit from ligation of the inferior vessels than from the superiors—preparatory to performing a resection later. It can be very easily accomplished through a transverse incision on a level at which one plans to make the incision for resection later on. The operation is much like the one for avulsion of the phrenic nerve. The inferior thyroid vessels lie just internal and a little anterior to the anterior scalene muscle. This point of ligation is a considerable distance away from the inferior laryngeal nerve. It is probably due to the size of the vessel and shutting off the greater blood supply to the gland that the best results occur.

When should stage-operations be performed? What influences the surgeon's judgment? Too much reliance cannot be placed on the basal metabolic rate. One low rate is better than many high rates. If the metabolic rate is over 30 there is danger, that is, in conjunction with other criteria. More than a favorable metabolic rate is gain in weight, especially recent—evidence that the patient is a fair risk. Persistence of such symptoms as tremor, excessive perspiration, and frequent bowel movements show severe toxicity. A pulse rate of more than 100 is not desirable. Mental symptoms indicate severe toxicity.

Occasionally, a patient may appear to be a good risk, until under an anesthetic, when signs such as a rising pulse rate or a rising blood pressure will appear. Then one must be ready to change his plan. At Bellevue Hospital the blood pressure is taken on every patient operated upon, and a rising blood pressure and pulse rate means a great deal. If that goes up during the first half of the procedure, one should make his plans to take out only one lobe. Also, if the patient takes a poor anesthetic, this is a sign that the patient will not do well.

Doctor McQuillan agreed that surgery, other than thyroid surgery, should not be undertaken on toxic thyroid patients unless in case of emergency.

With regard to the treatment of thyroid crisis, intravenous fluids with glucose, the oxygen tent and sedatives are commonly employed and are most valuable. The postoperative use of iodine is of doubtful value, according to most authorities. Personally, Doctor McQuillan felt unable to state that it is useful. There is some reason for giving thyroid gland substance in these crises. The latter may be due to a deficient thyroid hormone rather than too much of a normal one. It is difficult to understand how the small amount of thyroid tissue left after a subtotal thyroidectomy can function only after a

period of time has elapsed. This tissue has suffered too much trauma to function soon after operation, and it is soon after operation that thyroid crisis appears. Parallel with this reasoning, Rienhoff, at the last meeting of the International Goiter Congress, reported involution of hyperplastic thyroid tissue and amelioration of symptoms as a result of feeding thyroid substance. Also improvement of malignant postoperative exophthalmos has been noted following feeding of thyroid substance. Doctor McQuillan frequently gives thyroid extract to patients with crises—resulting in a lowered heart rate—thus relieving the strain until this self-limited storm has passed. There is a fraction of the thyroid hormone which stimulates the autonomic or vagus system, thus slowing the heart. This was first used in Bellevue, some 20 years ago, by the late Dr. John Rogers.

With regard to the three cases described by Doctors Grace and Weeks, Doctor McQuillan commented as follows: The first patient had been desaturated for six weeks. Then she was given iodine for two weeks prior to operation. The point is that she had had iodine off and on for a year, and had had her hyperthyroidism for a year, and it is only recently that Doctor Lahey made a statement that if an individual has been toxic—has been ill for a year at least with hyperthyroidism—he considers that one of his criteria for performing a stage-operation. This case, however, had only a moderate rise in basal metabolic rate and symptoms of a mild type, no loss of weight, even though there was no gain. She might have done better in a stage-operation but she seemed a good risk on the basis of the usual criteria. The second patient should have done well. She had had iodine over the proper time and seemed in good shape. This is one of the cases that seemed a good risk, but which occasionally develop a crisis. They are not common. Doctor Lahey calls them apathetic cases—not showing their symptoms well. Usually, the patient is an older individual whose response to stimuli is less, due to aged tissue, perhaps, and whose symptoms are not as pronounced as in the younger patient. The third case was a well recognized toxic and hazardous one all the way through, and in this patient the stage-procedure was the only safe way.

Dr. William Barclay Parsons (New York) said that even at the risk of repeating a point, he wished to state his firm support of Doctors Weeks and Grace in their idea of making an early decision on staging or not staging. But if one decides previously to perform a one-stage operation, he must always be ready to move in the direction of two stages at the time of operation if the findings indicate it, but should not change a decision to do a two-stage operation in favor of a one-stage procedure.

Dr. Charles Gordon Heyd (New York) said that it is readily apparent that there is a dilemma in thyroid surgery. Some surgeons give iodine to prevent thyroid crises. Others give iodine to bring about a resolution of thyroid activity, and a small group give thyroid substance after operation to avoid, if possible, thyroid crises. Doctor Heyd places very little confidence in basal metabolic rates as indicating when to operate, or as predicating any degree of recovery in hyperthyroidism. A young girl, of 21 years, with an exophthalmic goiter and a basal metabolic rate of 50, 60 or even 70, will withstand a subtotal thyroid resection with greater ease and safety than a woman of 55 years, with a basal metabolic rate of 20. Iodine has been used much too often and in too great a quantity. At the New York Post-Graduate Hospital sodium iodid, Gr. vii, once a day, intravenously, has been used for three to four days prior to operation, and has served to shorten the period of

preoperative preparation. The most outstanding aid in adequate preparation for operation is bed rest, complete and absolute.

Mortality in a measure is a matter of "the run of cases." There is much too great emphasis placed upon mortality. In any of the modern goiter clinics the mortality rate is a splendid achievement of surgery and the low mortality in the paper of Doctors Weeks and Grace indicates the excellent results of thyroid surgery.

Malignancy in goiter surgery is always to be considered. It occurred 15 times in 627 cases in the Post-Graduate Hospital clinic, with a mortality of 3 per cent. There are certain types of goiter that should be without any mortality. In nontoxic goiter at the New York Post-Graduate Hospital, from 1923 to date, there were 237 operations with no mortality. In the same period there were 103 toxic adenomata with 2.9 per cent mortality. In regard to the hyperthyroidism of Graves' disease type, from 1934 to 1939, there were 108 thyroid operations with no mortality, and there has been no mortality in the last 135 consecutive operations for Graves' disease, while for the period from July, 1935, to date there were 237 patients operated upon for Graves' disease with a mortality of 4.2 per cent.

In toxic, nodular goiters the surgeon is dealing with patients in the fourth, fifth or even the sixth decade of life, whereas in the goiters of Graves' disease type the patients are young with an acute toxemia.

The paper by Doctors Weeks and Grace indicates that surgery of goiter has passed out of the realm of goiter surgeons. With coordinated preoperative treatment and standardized operative technic, the 11 surgeons who contributed to this series have indicated the great degree of safety that appertains to goiter surgery and the limited mortality that may be obtained by any well-trained surgeon.

DR. RICHARD LEWISOHN (New York) disagreed with the statement that thyroid surgery should be the domain of the general surgeon. In order to obtain good results and to keep the mortality at a low level, surgery of the thyroid should be kept in the hands of those who are specially trained for this work. Otherwise results would not be as good as those reported here tonight by Doctors Grace and Weeks.

BRANCHIAL CYSTS AND SINUSES

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BRANCHIAL CYSTS AND SINUSES have been of interest ever since they were first reported by Hunczowski in 1789. Their etiology has never been satisfactorily explained although at present Wenglowski's[8] theories as to their origin are most usually accepted. No one type of treatment has found universal acceptance, and, although a large number of clinical discussions on this subject are reported, end-result studies are infrequent.

The treatment of any tumor or sinus of the neck requires an understanding of the many different pathologic entities which may arise in this region. The early recognition of branchial cysts and sinuses is important if they are to be properly managed.

In view of these facts, it seems of value to report 27 cases of branchial cysts and sinuses in which operation was performed at the Lahey Clinic during the past ten years, to comment on the embryology, differential diagnosis, the various plans of treatment that have been outlined in the literature, and end-result studies in our series of cases.

Wenglowski's work is based on anatomic and embryologic studies of a series of 246 cadavers and 75 embryos. His theory as to the etiology of branchial cysts and sinuses has been interpreted by Meyer.[6] This interpretation is generally recognized.

Meyer stated that the beginning of the branchial apparatus takes place in the second half of the first month of embryonic life, and in the course of the second month it completely disappears. The branchial apparatus extends forward, upward and orally. The pharyngeal apparatus extends posteriorly downward and below the mouth. The arches tend to grow closer in embryonic life, until the cleft disappears and the epithelium is displaced outward by the mesenchymal growth or by adhesion and obliteration.

The first arch forms the lateral portion of the upper lip and maxilla, the lower lip and mandible, and the body of the tongue. The second arch makes up the body of the hyoid bone, the stylohyoid ligament and muscle, the anterior portion of the base of the tongue, and the arcus palatoglossus. The third arch forms the greater cornu of the hyoid bone, the posterior portion of the base of the tongue, and the arcus pharyngopalatinus. The

Submitted for publication June 28, 1940.

fourth, fifth and sixth arches go to make up the soft parts of the neck surrounding the greater cornu of the hyoid.

The first cleft forms the external auditory canal and the lobe of the ear; the second cleft, the tonsillar fossa; the third cleft, the thymus; and the fourth cleft, the lateral lobes of the thyroid gland.

Meyer believes that the branchial apparatus belongs to the head and not the neck, and that any congenital pathologic condition referable to the branchial apparatus in human beings must rest along the mandible adjacent to the hyoid bone and the cornu of the hyoid bone. Nothing, in his opinion, below the lower level of the hyoid bone has any genetic relation to the branchial apparatus and all congenital anomalies caused by incomplete retrogression of the branchial apparatus must be located in the region around or above the lower border of the hyoid bone. Any congenital anomaly below this level is in definite relationship with the pharyngothymic duct and must be classified as a lateral cyst or fistula originating from this duct.

Bailey[1] believes that he disproves Wenglowski's theory that the branchial apparatus never leaves remnants in the neck below the level of the hyoid bone by citing a case of a persistent branchial cartilage found in the lower third of a child's neck, a position where a branchial fistula commonly opens.

Many other theories as to the origin of this condition are presented in the literature, and it must be assumed that the etiology of branchial cysts and sinuses is as yet not settled.

This condition is usually found in the younger age-groups and predominates in females. In our series, 56 per cent of the cases occurred in patients under 30 years of age. Seventy per cent of our patients were females.

Branchial fistulae are generally classified into three types: (1) Complete fistula, having both an internal and an external opening; (2) incomplete fistula, having either an internal opening alone and classified as an incomplete internal fistula; or (3) an external opening alone and being classified as an incomplete external fistula.

The usual symptoms that are attributed to branchial cysts and sinuses are a tumor of the neck; a sinus with an intermittent or continuous discharge of secretion; and recurrent attacks of inflammation. Occasionally, an unexplained cough may be attributed to a tract which has become adherent to the vagus nerve. In our series a swelling in the neck, a discharging sinus, and recurring attacks of inflammation were the presenting chief complaints. The duration of symptoms in our group extended from three days to 20 years, the average being four and one-half years.

The diagnosis of branchial cysts and sinuses is frequently difficult, and in our group only 57 per cent were diagnosed correctly previous to operation. Many conditions which commonly occur in the neck must be considered. Among these are: (1) Dermoid cysts. Tumors of this type can usually be differentiated by their content; hair and other foreign elements are frequently found. (2) Cystic hygromata. These tumors are usually

transparent and can be transilluminated. (3) Lipomata. Aspiration of these tumors reveals no fluid content, and their lobulated characteristics to palpation and firmness are suggestive. (4) Thyroglossal cysts and sinuses invariably occur in the midline, are attached to the hyoid and shift position with swallowing. (5) Tuberculous adenitis and sinuses in the neck may be very difficult to differentiate but their matted consistency and other foci of tuberculosis are suggestive. (6) Venous hemangiomata are usually deep-seated. Palpation of these tumors suggests the condition. (7) Deep cervical abscesses are characterized by local tenderness, induration, and systemic reactions. (8) Actinomycosis is rare but examination of the discharge will demonstrate the ray fungus. (9) Hodgkin's disease. An accurate differential diagnosis of this condition may require a biopsy. (10) Lymphosarcoma can usually be differentiated by the fact that it consists of a group of fused



FIGS. 1 and 2.—Typical example of branchiogenic cysts. Note the usual position anterior to the sternomastoid muscle and below the angle of the jaw.

adherent nodes. (11) Lymphatic leukemia can be diagnosed by blood studies and the usual physical findings of leukemia. (12) Carotid body tumors are found at the bifurcation of the carotid vessels and are characterized by a firm, elastic consistency. These tumors may or may not transmit an arterial pulsation. (13) Various cervical metastatic neoplasms may require biopsy for the establishment of the diagnosis but the finding of a primary growth is always suggestive.

Branchial sinuses and cysts in our experience have occurred in about equal frequency on both sides of the neck. Fifty-six per cent were found on the right and 40 per cent on the left. In one of our cases (4 per cent) the fistulae were bilateral.

A diagnosis of branchial cyst or sinuses can, therefore, be established ordinarily by remembering that they will be found in the neck anterior to the sternomastoid muscles, from the angle of the jaw to just above the clavicles, are of a congenital nature, and do not have any of the specific conditions mentioned above (Figs. 1 and 2).

Various types of treatment of this condition have been reported. Cutler and Zollinger[4] have advocated the employment of a sclerosing solution in the treatment of small branchial fistulae. Beck,[3] also, has advocated this treatment in fistulae of this type in infants. The danger of perforation

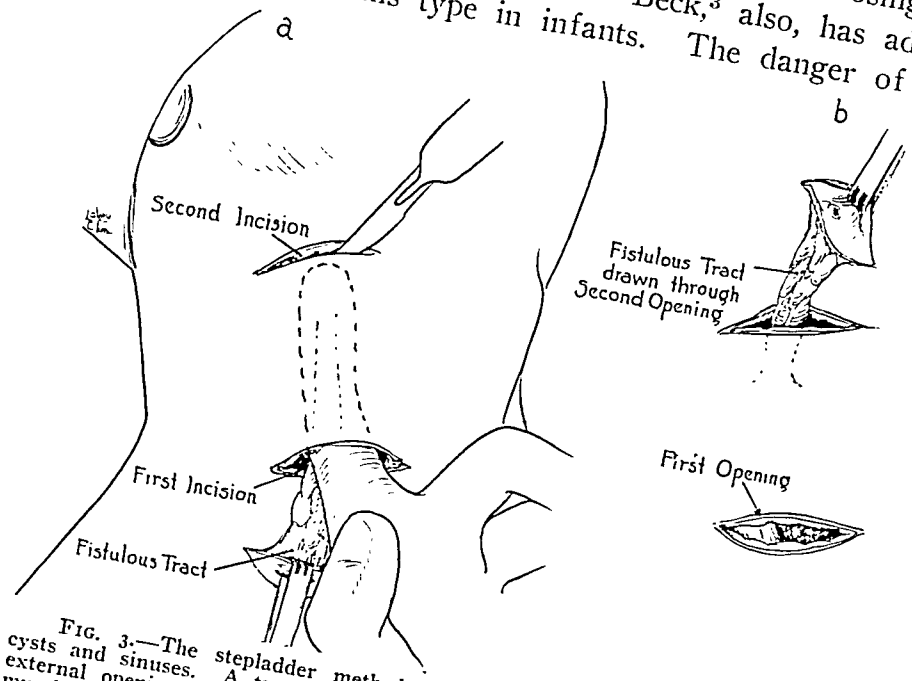


FIG. 3.—The stepladder method of surgical excision of branchiogenic cysts and sinuses. A transverse elliptical incision is first made around the external opening, the sinus tract dissected upward along the sternomastoid muscles. Care must be taken of the great vessels. A second transverse incision is then made at a higher level in the neck parallel with the first, and the dissected branchial fisula is then brought out through this second incision.

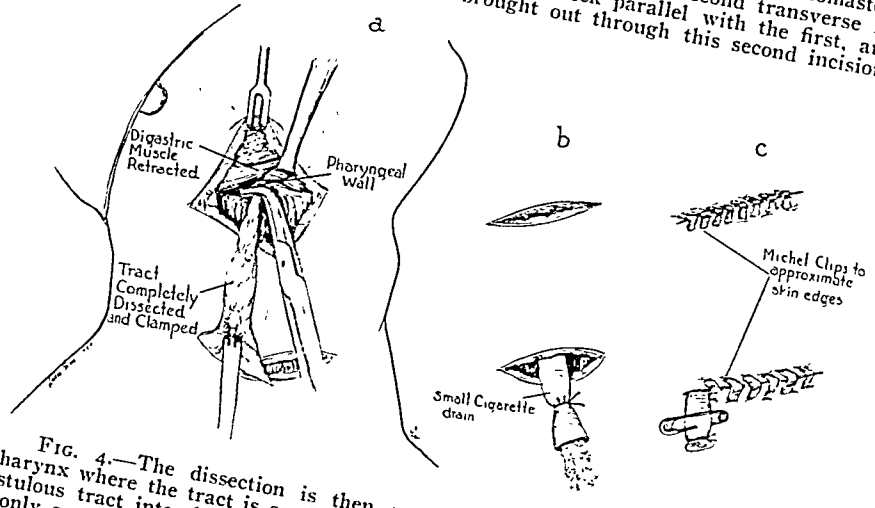


FIG. 4.—The dissection is then carried posteriorly to the wall of the pharynx where the tract is sectioned. We do not believe that inversion of the fistulous tract into the pharynx is necessary. The hypoglossal nerve is commonly seen in this part of the dissection and must be avoided. The wounds are closed about a small rubber-dam drain.

of the pharynx by necrosis and the marked inflammatory reaction which may result are objections to this type of treatment.

A majority of surgeons advocate complete excision of the sinus tract or cyst and suggest various methods. Beck has advocated the use of a collar incision for this procedure, such as is employed in operations on the thyroid. von Hoeker[7] suggests the insertion of a probe into the tract with fixation of the tract to the probe by a ligature, which he believes facilitates

removal. Baumgartner[2] emphasizes the importance of inverting the stump of the fistula into the cavity of the pharynx whenever possible. Gaston,[5] reporting a series of 29 cases from the Cleveland Clinic, does not believe that the inversion of the stump of the fistula into the cavity of the pharynx is necessary, although he agrees that complete surgical extirpation of the tract is essential.

Bailey[1] uses the so-called stepladder method of surgical excision, and this operation has been utilized in the majority of our cases (Figs. 3 and 4). A transverse incision is first made about the external orifice. The skin is freed-up, gentle traction is then exerted on the fistulous tract, and the dissection carried up around the tract as far as possible. At this point, a second transverse incision is made parallel with the first, at a higher level, and the tract is brought up from the first incision out through the second higher incision. This allows an adequate exposure during the dissection of the tract up to the wall of the pharynx, where adequate exposure is so essential.

At times, it may be of assistance to place one finger inside of the mouth and apply pressure against the pharyngeal wall so that danger of perforation of the pharyngeal wall can be minimized. We do not think that inversion of the fistula into the pharynx is necessary and have never done it.

Treatment may have to be modified because of previous unsuccessful attempts at removal. In 34 per cent of our cases previous operation or roentgenotherapy had been carried out.

At the Lahey Clinic, follow-up studies have been made in 27 cases, occurring during the last ten years. In all cases complete surgical excision, as described previously, was performed. Recurrence has not taken place in any of the cases.

SUMMARY

The embryology of branchial cysts and sinuses has been reviewed. The differential diagnosis has been presented, and various plans of treatment outlined.

End-results are reported in 27 cases in which complete surgical excision was performed.

REFERENCES

[1] Bailey, H.: The Clinical Aspects of Branchial Fistulae. Brit. Jour. Surg., 21, 173–182, October, 1933.

[2] Baumgartner, C. J.: Congenital Lesions of the Neck. Jour. Am. Med. Assn., 113, 1860–1864, November 18, 1939.

[3] Beck, W. C.: Branchiogenic Cysts in Infancy. Surgery, 1, 792–799, May, 1937.

[4] Cutler, E. C., and Zollinger, R.: Use of Sclerosing Solutions in the Treatment of Cysts and Fistulae. Am. Jour. Surg., 19, 411–418, March, 1933.

[5] Gaston, E. A.: Cysts and Sinuses of the Neck. Cleveland Clin. Quart., 3, 311–322, October, 1936.

[6] Meyer, H. W.: True Branchiogenic Cyst and Fistula of the Neck. Arch. Surg., 35, 766–771, October, 1937.

[7] von Hoeker: Quoted by Beck.[3]

[8] Wenglowski, R.: Über die Halsfisteln und Cysten. Arch. f. klin. Chir., 98, 151–208, 1912; 100, 789–892, 1912–1913.

INTRA-ABDOMINAL APOPLEXY

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SPONTANEOUS HEMOPERITONEUM is not too unusual an occurrence. Even excluding spontaneous hemoperitoneum, of genital origin in the female, Morridor and Olivier[1] were able to collect 432 cases from the literature. On the other hand, massive spontaneous intraperitoneal hemorrhage resultant from the rupture of a small intra-abdominal blood vessel independent of any direct trauma to the abdomen, is a rare accident. The condition has very aptly been designated "intra-abdominal apoplexy," to denote its close resemblance both in spontaneity and nature to the much more frequent and better known cerebral apoplexy. An exhaustive study of the literature has revealed but 19 cases which might be so classified.* To these 19, we have added a case of our own and briefly tabulated (Table I) what seemed to us the essentials in each. It is only through the repeated reportings and tabulations of such cases, that characteristics, if any, will become recognized which may serve in the diagnosis and treatment of future cases.

Case Report.—The patient, male, age 52, presented himself at the hospital at 10:00 P.M., May 2, 1939, complaining of dull, persistent pain in the abdomen since April 29, 1939, which had become steadily worse. The pain, which began insidiously, was constant, dull, and diffuse over the midabdomen without any radiation. Vomiting had occurred but once, and that was on the day of admission. The vomitus was of a nondescript type. The bowels had been regular and the appetite undisturbed. There were no urinary symptoms.

The patient had known for several years that he had hypertension. For the past two months he had been receiving treatment for attacks of precordial pain and dyspnea which would occur while walking home from work. He had had a bilateral herniorrhaphy and appendicectomy in 1935. For the past few years he had noted failing vision. There was no history of any digestive disturbances. The remaining past history and the family and social history were irrelevant.

Physical Examination.—As seen on admission, the patient was resting flat in bed apparently fairly comfortable, despite his description of pain of a rather severe character. The state of nutrition was fair. There was no cyanosis, jaundice or dyspnea. He appeared alert, oriented and cooperative. Temperature 98° F.; pulse 90; respirations 21; blood pressure 240/170.

The heart was markedly enlarged. There was a presystolic gallop rhythm present with a systolic murmur at the apex and base and a split pulmonic second sound. The aortic second sound had a tambour quality. The abdomen was flat and the wall was soft and relaxed. Tenderness was obtained in the epigastric area on deep pressure. The

Submitted for publication January 8, 1940.

* Since this paper was submitted an additional case has been reported (Crile, G., Jr., and Newell, E. T., Jr.: Abdominal Apoplexy, J.A.M.A., 114:1155, 1940).

peripheral blood vessels were firm and thickened. Ophthalmoscopic examination revealed a blurring of the disk margins and hypertensive neuroretinopathy, Grade III. Because of the marked hypertension, the apparent cardiac and arterial changes and the essentially negative abdominal findings, a tentative diagnosis of "abdominal angina" was made and the patient was kept at rest in bed under observation.

Laboratory Data.—W.B.C. count on the morning following admission was 16,000, 86 per cent neutrophiles. Repeated counts yielded figures ranging between 10,000 and 14,200 W.B.C.

An electrocardiogram revealed myocardial disease with an intraventricular conduction defect. A flat roentgenogram of the abdomen was negative and a gastro-intestinal roentgenologic examination revealed nothing more than spasticity in the pyloroduodenal region. Repeated uranalyses showed a low specific gravity with a profusion of casts and W.B.C. Repeated kidney function tests, likewise, showed impaired renal function. The blood Wassermann was negative. All other studies yielded results within normal limits.

Course in Hospital.—The presenting complaint of diffuse midabdominal pain of a dull nonradiating type persisted after admission until May 8, 1939. On the evening of May 8, 1939, the temperature began to mount to reach a high of 103° F. at noon of May 9, 1939, then declined to return and remain normal about noon of May 10, 1939. The patient was completely asymptomatic and examination revealed nothing to account for this temperature elevation other than slight distention of the abdomen. A repeat roentgenogram of the chest and electrocardiogram were both negative. Abdominal distention remained, despite regular bowel evacuations and a lack of any complaints on the part of the patient.

Shortly before 3:00 A.M., May 16, 1939, the patient complained of sudden severe, nonlocalized abdominal pain and requested a bedpan. While on the bedpan he vomited about ten ounces of a dark material that seemed blood-tinged, following which he went into a partial collapse. Examination revealed a temperature of 98° F. (rectal), pulse 98; respirations 28; blood pressure 90/70. The skin was cold and clammy. The abdomen was moderately distended without tenderness or rigidity. There was no dulness in the flanks and peristalsis seemed somewhat hyperactive. Shock treatment was instituted and about one-half hour later the blood pressure had risen to 110/80. The abdomen continued to become more distended and peristalsis became entirely inaudible. Moderate generalized tenderness appeared over the abdomen and the walls were felt to become more tense. A flat film of the abdomen, taken at this time, was negative. It was our impression that the patient had suffered a mesenteric thrombosis and an operation was decided upon as soon as he had responded to the shock treatment that had been instituted.

Operation.—May 16, 1939 (N. S. R.): Under ether anesthesia, an upper right rectus incision was made into the peritoneal cavity. A considerable amount of blood exuded. It was dark in color and apparently free of any stomach or intestinal contents. The blood was gradually, and slowly, removed. In excess of 1,000 cc. of blood was aspirated and considerably more was lost from the wound primarily. The abdominal wound was enlarged to obtain a better view.

Operative Pathology.—The mesentery of the small bowel showed no point of bleeding. Examination of the omentum showed no evidence of bleeding. The stomach (only the pyloric and fundal portions could be examined) showed no evidence of a bleeding point. The duodenum appeared normal. There was no evidence of bleeding from the liver, although there seemed to be just as much blood immediately below the liver as there was in the pelvis. The spleen appeared intact and gave no evidence of bleeding in or about it. With practically all of the blood in the peritoneal cavity removed, and inspection revealing no bleeding point or site of continued oozing, the abdomen was closed with through and through silkworm sutures, without drainage. The skin was closed with silkworm gut. During this extensive exploration, the patient went into

deeper shock, despite the fact that intravenous administration of glucose and saline, acacia and blood were administrated during the operative procedure.

Postoperative Course.—Postoperative recovery proceeded uneventfully with the exception of abdominal distention, for which more or less continual duodenal suction syphonage (Wangensteen) was maintained. It was found necessary to keep the Wangensteen apparatus attached and tube suction continued for about 15 days, during which time there was, of necessity, a deficiency in protein and vitamin intake. On June 6, 1939, moderate anasarca appeared with bilateral hydrothoraces and abdominal ascites. The R.B.C. count just prior to this time was 3.1 million, with 55 per cent hemoglobin. Although the total plasma protein was at the lower limits of normal, 6.45 grams per cent, it was felt that some of this represented hemoconcentration from dehydration and that the status of the patient represented primarily an advanced degree of postoperative nutritional and vitamin deficiency. Following paracentesis of sanguineous-tinged effusions from both pleural sacs and from the abdomen, a high protein and vitamin diet was instituted, forti-

TABLE I

ESSENTIAL DATA IN 20 CASES OF INTRA-ABDOMINAL APOPLEXY

Case No.	Author	Year	Sex	Age	Anatomic Location	Cardiovascular System	Operation	Result	Autopsy
1	Barber[2]	1909	F.	32	No definite bleeding point	Apparently normal	Yes	Rec.	—
2	Churchman[3]	1911	M.	48	No definite bleeding point	Apparently normal	Yes	Died	No
3	Florence & Ducuing[4]	1913	F.	—	Sup. mes. art.	—	No	Died	Yes
4	Hilliard[5]	1918	M.	48	N.D.B.P.—(transmesocolon)	Hypertension 160–190 (systolic)	Yes	Died	No
5	Starcke[6]	1923	M.	60	Gast.-duo. art.	Hypertension 155	Yes	Rec.	—
6	Budde[7]	1925	M.	27	L. gast.-epip. art. (aneurysm)	Normal	Yes	Rec.	—
7	Green & Powers[8]	1931	F.	54	L. gast. art.	Hypertension 270/145	Yes	Rec.	—
8	Morgue-Molines & Cabanac[9]	1933	M.	56	L. gast. art.	(Questionable)	Yes	Rec.	—
9	"	1933	—	—	L. gast. art.	Art.-sclerosis & hypertension 230/130	Yes	Rec.	—
10	" (Case of Rud's)	1933	F.	73	L. gast.-epip. art.	Marked art.-sclerosis at P.M.	Yes	Died	Yes
11	Hartley & McKechnie[10]	1934	M.	31	No definite bleeding point	Apparently normal	Yes	Died	Yes
12	Thompson & Dunphy[11]	1935	F.	62	L. gast. art.	Hypertension 170/100	Yes	Rec.	—
13	Buchbinder & Greene[12]	1935	M.	57	R. gast. art.	Hypertension 190/115	Yes	Rec.	—
14	Moorehead & McLester[13]	1936	M.	44	R. & L. gast. art.	Hypertension 220/140	No	Died	Yes
15	"	1936	M.	50	Sup. mesen. art.	Myocardosis with arteriosclerosis	No	Died	Yes
16	Bruce[14]	1937	M.	34	No definite bleeding point	Apparently normal	Yes	Rec.	—
17	"	1937	M.	75	Mid. colic art. (aneurysm)?	Abdominal vessels normal	—	—	—
18	Morton[15]	1938	M.	72	Sup. mes. art.	(Questionable) B.P. 100/70—155/96	Yes	Rec.	—
19	Silverstone[16]	1938	M.	52	No definite bleeding point	Hypertension 200	Yes	Died	—
20	Berk, Rothschild & Doane	1939	M.	52	No definite bleeding point	Hypertension 250/160. Myocardosis & art.-scler.	Yes	Rec.	—

fied by several repeated blood transfusions and daily administrations of vitamin concentrates. Under this regimen the patient made a slow but steady improvement. He was finally permitted out of bed on July 5, 1939, and was discharged in fairly good condition on July 12, 1939.

Follow-up.—The patient was last seen again on October 1, 1939. He had had no digestive disturbances and was free of all abdominal complaints. Since his discharge he had about four attacks of paroxysmal nocturnal dyspnea. He was ambulatory and his color and nutrition were good. His temperature was 97° F., pulse 76, respirations 20, blood pressure 250/160. As noted on earlier examinations, the heart was enlarged. There was a presystolic gallop and a systolic murmur at the apex and base. The aortic second sound had a tambour quality and the pulmonic second sound was split. Ophthalmoscopic examination revealed an hypertensive retinopathy, Grade III. These findings were exactly similar to those on admission and discharge from the hospital.

COMMENT.—An analysis of the 20 cases of intra-abdominal apoplexy, tabulated in Table I, reveals some interesting points. The accident occurred much more frequently in males, with the ratio of occurrence approximately three males to one female. The ages varied from 27 to 73, but the average age was 51.5 years, with the greatest frequency of occurrence between the ages of 45 to 55 (Table I).

Ten cases (50 per cent) gave evidence at some time or other of a definite hypertension. Two other cases, or 10 per cent, in which no blood pressure reading was noted, were described as showing marked arteriosclerosis at postmortem examination. Thus, 60 per cent of the cases in this series presented evidence of organic cardiovascular disease in the nature of a diffuse vascular sclerosis (Table II).

TABLE II

SUMMARY OF ANATOMIC FINDINGS IN 20 CASES OF INTRA-ABDOMINAL APOPLEXY

Cardiovascular Changes				Definite Bleeding Point					No Definite Bleeding Point				
Hypertension		Arteriosclerosis		No. of Cases	Per Cent	Average Age	Normal C-V System		No. of Cases	Per Cent	Average Age	Normal C-V System	
No. of Cases	Per Cent	No. of Cases	Per Cent				No. of Cases	Per Cent				No. of Cases	Per Cent
10	50	2	10	14	70	56.5	1	7	6	30	41.5	4	65.6

In six cases (30 per cent) it was specially noted that no definite bleeding point could be found. It is of interest that these cases occurred among the younger individuals—the average age of this group being 41.5 years compared with 56.5 years in the group in which a definite bleeding vessel was found. In four of these six cases (66 2/3 per cent) the cardiovascular state was noted as being apparently normal (Table II). To state it another way: Of the five cases in the reported series in which it was definitely noted that the cardiovascular state was apparently normal, there were four cases (80 per cent) in which no definite bleeding point could be found either at operation or at postmortem examination. This close association between a younger-age occurrence, a relatively normal cardiovascular apparatus and the inability to demonstrate a bleeding point was striking and noteworthy. The practical

implication of this association becomes apparent when the operative results are analyzed.

Sixteen of the 20 cases in the series (80 per cent) came to operation (Table III). Of these 16, 11 cases (69 per cent) recovered. Of the five (31 per cent), in which operation resulted in death, four were cases in which no definite bleeding point could be found. It would seem from this, that despite the occurrence of a massive intraperitoneal hemorrhage if, at opera-

TABLE III

SUMMARY OF OPERATIVE RESULTS IN 20 CASES OF INTRA-ABDOMINAL APOPLEXY

Operated		Recovered				Died			
				No Def. Bl. Pt.				No Def. Bl. Pt.	
No. of Cases	Per Cent	No. of Cases	Per Cent	No. of Cases	Per Cent	No. of Cases	Per Cent	No. of Cases	Per Cent
16	80	11	69	1	9	5	31	4	80

tion, a definite bleeding point can be located and the bleeding vessel ligated, the chance of recovery is excellent. This is especially to be emphasized, since we have been unable to find any reported case of repeated occurrence of intra-abdominal apoplexy. Thus, it would appear that in this condition there might be some advantage favoring the hypertensive-arteriosclerotic individual, in that such patients are much more likely to present a definite bleeding point that would permit of ligation.

In no instance was a correct diagnosis made prior to operation. The majority of cases were felt to represent perforated peptic ulcers. Of the various diagnoses made, the one which would seem most nearly related to the actual condition found was "mesenteric thrombosis." In our case the latter was the preoperative diagnosis. All cases were considered as acute abdominal catastrophes, but in every instance the encountering of an abdomen full of blood occurred as a distinct surgical surprise. A close analysis of the symptoms and signs in each of the reported cases reveals no one thing pathognomonic of the condition. There seems little, if anything, that can be recognized with any degree of certainty, to distinguish it from other acute abdominal emergencies. Of course, the absence in the history of such gross things as trauma, dominant digestive complaints, or previous similar occurrences, are of some aid in the differential diagnosis.

Morridor and Olivier,[1] in their exhaustive review of spontaneous hemoperitoneum in men, resulting from various causes, call attention to several signs and symptoms that were common to most of the cases. They all showed abdominal signs of peritoneal irritation, an elevated leukocyte count (over 10,000 in most cases), and a lowered erythrocyte level.

The quantitative status of the erythrocytes calls attention to the usefulness, in these cases, of recognizing that the clinical picture of vascular collapse which they present is due to internal hemorrhage rather than to shock from other causes. Moon[18] has called attention, on many occasions, to the significance of hemoconcentration as a diagnostic finding in true shock. A

demonstration of hemoconcentration by either repeated hematocrit readings, specific gravity determinations, hemoglobin determinations, or red blood cell counts would indicate a state of shock due to causes other than hemorrhage, whereas the failure to demonstrate hemoconcentration by the same means might suggest hemorrhage as a causative factor. Such a differentiation would appear to be of paramount importance in cases of spontaneous hemoperitoneum, where the most frequent condition, suspected clinically, is ruptured peptic ulcer with shock and, not in a single instance, internal hemorrhage.

There was noted in several of the cases, including our own, a phenomenon, to which Morridor and Olivier[1] have also called attention, namely, that a number of these cases described the occurrence of indefinite abdominal pain of variable nature prior to the acute accident for which they were eventually seen. They, in fact, found that about 25 per cent of the cases which they reviewed, described such pains months or years preceding the acute attack. They also described what they termed "treacherous calm" in about 20 per cent of their cases during which, in a few instances, clinical remissions were so great as to permit return to work.

The use of abdominal paracentesis as a diagnostic procedure in the presence of suspected hemoperitoneum has been recently reapplied by Johnston.[19] Despite the indifferent success of others who have employed the procedure in the past, Johnston feels that the danger of visceral injury is negligible and that exploratory abdominal puncture with the use of a trocar can be of inestimable value in the diagnosis of hemoperitoneum.

The etiology of the condition affords much interesting speculation. The high incidence of hypertension and arteriosclerosis in the reported series of cases (60 per cent) would strongly suggest that local disease of the blood vessels must be the basic, underlying factor. The recent report of Morlock[17] would tend to substantiate such a conclusion. He was able to demonstrate that the blood vessels of the gastro-intestinal tract of hypertensives of all ages as compared to normal individuals, showed measurable thickening of the arteriolar wall and reduction of the ratio of wall to lumen. There occurred early in such blood vessels, hyperplasia of the nuclear elements of the media followed later by degeneration and fibrosis. It is much more difficult to account, on the same local vascular disease basis, for the hemorrhages occurring in the younger individuals with an apparently normal vascular tree. The close association was pointed out above of a younger-age occurrence, the presence of an apparently normal vasculature, and the inability to demonstrate a definite bleeding point (Table II). Bruce,[14] discussing the cause for intra-abdominal apoplexy, suggested the presence in the abdominal vessels of a congenital weakness, similar to that which leads to aneurysm of the basal cerebral arteries. He quoted the work of Forbus, whose study on the development of the mesenteric vessels indicated that at the branchings of the arterial tree a gap exists temporarily between the independent formation of muscle coats on each branch. It was felt that developmental defects at the branchings, resulting from deficiency in the formation of muscle coats, might

explain the occurrence of small aneurysmal formations. Small aneurysmal dilatations, similar to that seen in cerebral arteries, have been reported in the mesenteric, pulmonic and renal arteries. Such conditions would lend an easy explanation for the occurrence of a massive intraperitoneal hemorrhage in younger individuals, free of known organic vascular disease. There is, of course, no sure proof that such a condition actually exists, but the demonstration of small aneurysmal rupture in Cases 6 and 17, where the surrounding abdominal vessels were noted to be normal, would lend support to such a theory.

The spontaneous feature in all these cases of intra-abdominal apoplexy is an important one. The precipitating cause is, in most instances, hidden and unexplainable. Given a basic, underlying local disease or congenital defect whose very nature is such as to weaken the vessel at the local site, then the addition of anything that would tend to raise the intravascular pressure within that vessel might well result in a rupture at the weakened site. In that way, and for that reason, hypertension, possibly, is found in so large a percentage of cases. Likewise, too, the use of pitressin, as in Morton's[15] case, sudden emotional strain, excessive eating, coitus, heavy lifting, and anything else which might raise the blood pressure could well predispose to a "blowing out" of a blood vessel.

Summary

(1) A case of massive spontaneous intra-peritoneal hemorrhage ("intra-abdominal apoplexy") is reported.

(2) Nineteen similar cases reported in the literature are analyzed.

(3) The striking features of the condition are noted, and a discussion is made of the possible etiology, the treatment and its results.

Conclusions

(1) Massive spontaneous intraperitoneal hemorrhage resulting from the nontraumatic rupture of a small intra-abdominal blood vessel (so-called "intra-abdominal apoplexy") is a rare condition, the occurrence of which is being reported with greater frequency.

(2) There is nothing pathognomonic in either the symptoms or signs that permit a certain preoperative diagnosis.

(3) The condition should be considered in all cases in which there occurs sudden severe abdominal pain, shock, and signs of peritoneal irritation especially in a known hypertensive.

(4) Hypertension and arteriosclerosis seem to be the dominant factors in the etiology of the condition. The possibility of the occurrence of small localized aneurysmal dilatations, particularly in younger individuals, has been suggested.

(5) Early operation, with ligation of the bleeding point, if possible, is the only treatment. This treatment is one which offers a high chance of recovery if a definite bleeding point be found.

REFERENCES

[1] Morridor, H., and Olivier, C.: Spontaneous Hemoperitoneum in Men. Jour. de Chir., 53, 1, January, 1939.

[2] Barber, M. C.: Intra-abdominal Hemorrhage Associated with Labor. Brit. Med. Jour., 2, 203, July 24, 1909.

[3] Churchman, J. W.: Spontaneous Intraperitoneal Hemorrhage. Am. Jour. Med. Sci., 142, 825, 1911.

[4] Florence, M., and Ducuing, M.: Contusion de rein. Hémopéritoine Guérison Spontanée. Valeur diagnostique de la ponction exploratrice due cul-de-sac de Douglas. Bull. et mém. soc. nat. de chir., 39, 645, 1913.

[5] Hilliard, J. W.: Spontaneous Hemorrhage into the Peritoneal Cavity in Arteriosclerosis. Brit. Med. Jour., 1, 231, February 23, 1918.

[6] Starcke, G.: Tiefaelde of "Spontan" Ruptur of a. Gastroduodenalis. Ugesk. f. laeger, 85, 963, December 27, 1923.

[7] Budde, M.: Operatin Geheilte Spontan ruptur der Arteria Gastroepiploica Sinistra. München. Med. Wchnschr., 72, 1383, August 14, 1925.

[8] Green, W. T., and Powers, J. H.: Intra-abdominal Apoplexy. ANNALS OF SURGERY, 93, 1070, May, 1931.

[9] Mourgue-Molines, and Cabanac: Abondante hémorrhagie intra-péritonéale par infarctus de l'épiploon-gastro-hépatique. Bull. et mém. soc. nat. de chir., 59, 720, May 13, 1933.

[10] Hartley, H., and McKechnie, D. M.: A case of "Splanchnostaxis." Lancet, 1, 289, 1934.

[11] Thompson, K. W., and Dunphy, J. E.: Intra-abdominal Apoplexy. ANNALS OF SURGERY, 102, 1116, December, 1935.

[12] Buchbinder, J. R., and Greene, E. I.: Intra-abdominal Apoplexy. J.A.M.A., 105, 874, September 14, 1935.

[13] Moorehead, M. T., and McLester, J .S.: Abdominal Apoplexy. J.A.M.A., 106, 373, February 1, 1936.

[14] Bruce, J.: Massive Spontaneous Intraperitoneal Hemorrhage. Lancet, 1, 1451, June 19, 1937.

[15] Morton, C. B.: Intra-abdominal Apoplexy. Arch. Surg., 36, 723, 1938.

[16] Silverstone, M.: Massive Spontaneous Intraperitoneal Hemorrhage. Brit. Med. Jour., 1, 230, January 29, 1938.

[17] Morlock, C. G.: Arterioles of the Pancreas, Liver, Gastro-Intestinal Tract and Spleen in Hypertension. Proc. Staff Meet., Mayo Clin., 14, 214, April 5, 1939.

[18] Moon, V. H.: Shock and Related Capillary Phenomena. Oxford Press, New York, 1938.

Idem: The Occurrence and Clinical Significance of Hemoconcentration. Ann. Int. Med., 13, 451, 1939.

Idem: Early Recognition of Shock and Its Differentiation from Hemorrhage. ANNALS OF SURGERY, 110, 260, 1939.

[19] Johnston, C. C.: Diagnostic Paracentesis in Suspected Intra-abdominal Hemorrhage. ANNALS OF SURGERY, 111, 93, January, 1940.

INTRACTABLE GASTRIC ULCER WITH FINAL MALIGNANT CHANGE ASSOCIATED WITH A BENIGN TUMOR OF THE BRAIN*

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DURING the past ten years our whole attitude toward the problem of gastric and duodenal ulcer has undergone a radical change. Formerly, the diagnosis and treatment of gastric or duodenal ulcer directed attention chiefly to the local lesion and largely ignored constitutional factors, which we now know to be of fundamental importance. At present, ulcers are believed to be due to a combination of factors acting in a susceptible individual.

The two opposing conceptions of the etiology of ulcer have contended for first place for many decades: First, the view suggested by Rokitansky, in 1841, that some central factor is the real cause of all ulcers; second, the view upheld by Virchow, in 1853, that local factors are quite sufficient to explain the pathogenesis of ulcer.

Undoubtedly both the central and the local factors are important but the accumulating evidence suggests that central factors, either in the nature of organic disease of the brain, or neurogenic stimuli from the cortex in a vagotonic type of individual, are fundamental or predisposing causes of peptic ulceration.

The local factors which are of significance will merely be enumerated here. They are: Trauma; acid chyme erosion; and bacterial invasion. These factors are of importance, but it is probable that their effect is secondary to the preexisting central disturbance. Alterations in the gastric motility and secretion and actual peptic ulceration may be produced by stimuli originating in higher centers.

The view one takes as to the relative importance of the central or local group of factors will influence one's line of treatment. If the predominant factor in a given case is central—that is to say due to either a functional or organic cerebral disturbance—and it cannot be satisfactorily controlled, then any form of local surgical therapy is apt to be followed by early recurrence of the ulcer. In this type of case medical treatment should be persisted with. However, if for any reason operative interference becomes necessary, a radical procedure must be adopted. On the other hand, if the central factors are negligible or controllable, and the local factors predominant, then medical treatment or conservative surgery offers the patient a much greater chance of cure.

* Read at the Annual Meeting of the Canadian Medical Association, Montreal, June, 1939. Submitted for publication November 24, 1939.

The growth of the neurogenic hypothesis has been slow since it was originally suggested by Rokitansky. The evidence on which it is based is threefold: First, the existence of cerebral lesions and peptic ulcers in the same

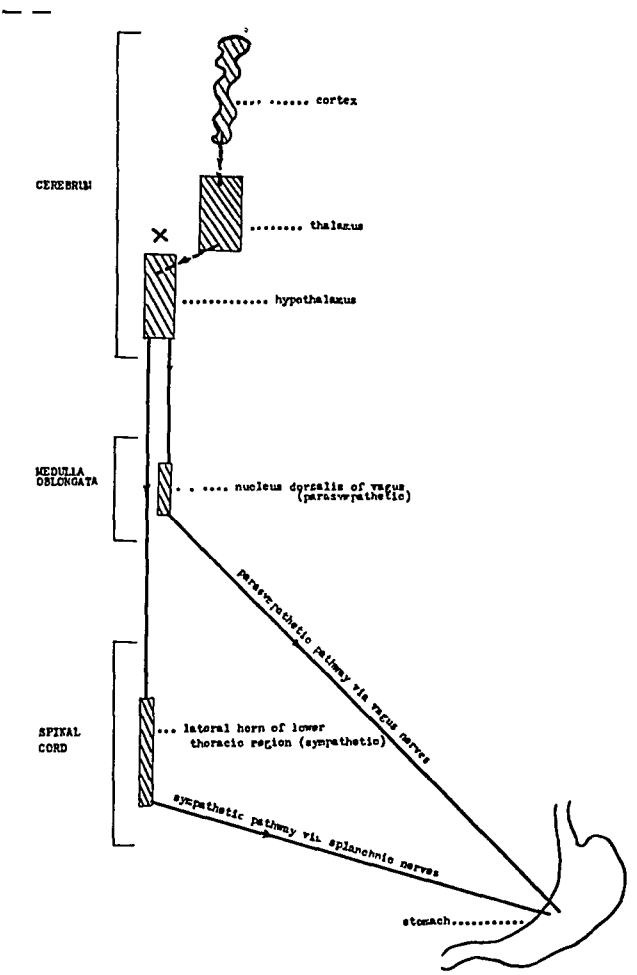


FIG 1.—A schematic representation of some current ideas regarding nervous control of the stomach. The arrows indicate the direction of controlling impulses. In the diagram pre- and post-ganglionic fibers and the intervening synapse are not distinguished. The hypothalamus is known to exert some control over both sympathetic and parasympathetic systems; it may coordinate them, but our knowledge of the functional significance of the numerous hypothalamic nuclei is not sufficiently definite to warrant inclusion in such a diagram. There is good evidence that the nervous apparatus controlling the gastrointestinal canal includes the cortex, a probable pathway (though not necessarily the only one) through which the cortex affects the hypothalamus (via the thalamus) is suggested by broken lines. The X indicates the approximate position of the tumor in our case, it may have affected the hypothalamus itself, or some fibers transmitting controlling impulses to the hypothalamus.

We are indebted to Dr. I. M. Thompson, Professor of Anatomy, University of Manitoba, for the diagram illustrating the nervous control of the stomach.

individual; second, the occurrence of peptic ulceration in infants following cerebral injury; third, there is considerable experimental evidence to show that induced vagal and sympathetic disturbances will produce ulcer in animals,

not to mention the production of ulcer from stimulation or injury of cortical areas.

Cerebral Lesions and Peptic Ulcer.—Hoffmann,[9] in 1868, had a patient under observation who had a tumor of the pons and medulla. The patient died of perforated gastric ulcer. Arndt,[10] in 1874, reported a patient with an interpeduncular sarcoma who developed a fatal gastric ulcer. von Winiwarter,[11] in 1911, recorded two cases of fatal gastric hemorrhage following a brain operation. Beneke,[12] in 1908, found that 70 patients out of 239 with fatal gastric hemorrhage had associated intracranial lesions. Mogilnitsky,[5] in 1925, reported eight cases of brain tumor who had peptic ulcers. Cushing,[8] in 1932, reported 11 cases of intracranial lesions with associated gastric or duodenal ulcer.

Ulcers and Intracranial Injury in the Newborn.—The extreme rarity of peptic ulcer in infancy in the absence of intracranial lesions, and the comparative frequency with which ulcers are found in association with brain injuries in the newborn suggest an etiologic relationship between brain lesions and ulcer. von Preuschen[13] recorded a case of intracranial hemorrhage and gastric erosion. von Preuschen and Pomorski[14] performed a number of experiments upon animals in which they injured the hindbrain and produced gastric erosion. Blackfan[20] recorded four cases of esophageal perforation in the newborn, and in all of these patients intracranial hemorrhage was present.

Experimental Neurogenic Ulcer.—The sympathetic and parasympathetic nervous systems together constitute a balanced mechanism as far as gastric motility and secretion are concerned. Experimental attack on the vagus or the sympathetic may result in gastric ulceration. Theoretically, division of the vagus should not produce gastric ulceration. Actually, however, ulcers have been produced by this procedure. Manning, Hall and Banting,[3] in 1937, showed that prolonged vagal stimulation would give rise to areas of hemorrhage and congestion in both pylorus and duodenum. Atropine prevented such lesions, while eserine accentuated them and resulted in ulcer formation. Division of the sympathetic pathways to the stomach gives rise to an uncontrolled vagus action. Gastric erosions and ulcerations have been recorded by a number of observers following section of sympathetic nerves to the stomach.

Schiff[15] showed that stimulating the vagus via the higher centers, namely, the hypothalamus, gave rise to dilatation of the vessels in the stomach musculature. On the other hand, stimulation of the sympathetic through the higher centers resulted in constriction of the vessels in the stomach mucosa and in decreased peristalsis. Ebstein[16] injured the anterior corpora quadrigemina and produced ulcers in nine out of 23 experimental animals. Burdenko and Mogilnitsky,[6] in 1925–26, punctured the hypothalamus and, as a result, obtained gastric erosions and perforations and in some instances chronic gastric ulcers.

Pharmacologic Investigations.—Eppinger and Hess,[17] in 1910, showed that certain individuals may be described as vagotonic, and that this type of individual is susceptible to ulcer formation. These people react excessively to

certain vagal stimulating drugs, such as pilocarpine and physostigmine. In 1914, Westphal[18] showed that subcutaneous injections of pilocarpine or physostigmine in experimental animals gave rise to ulcer if the stomach contained acid and was digesting food at the time of the injection. Ettinger, Hall, and Banting,[4] in 1936, found that by repeated intravenous injections of acetylcholine in dogs, the younger animals developed severe congestion of the gastric and duodenal mucosa. Clinically, this was manifested by retching, vomiting, diarrhea, and melena. Older animals showed a lesser tendency to develop these gastro-intestinal lesions; instead, they developed marked changes in the coronary vessels.

Light, Bishop, and Kendall[19] introduced into the ventricles of the brain pituitrin and pilocarpine in small doses, and were able to produce gastric erosions similar to those resulting from vagus stimulation. Their experiments suggested that the vagus has a controlling center situated in the diencephalon. Roentgenographic and chemical examination of the stomach in experimental animals, following the intramuscular and the intraventricular injection of pituitrin, pilocarpine and histamine, show hypermotility, hypertonicity, and hyperchlorhydria. All of these abnormalities are commonly present in chronic gastric or duodenal ulcer.

The appended case report is presented for three reasons: First, because it demonstrates an apparent causal relationship between an intracranial lesion and a chronic gastric ulcer; second, because this gastric ulcer failed to respond to any form of treatment, possibly due to the persistence of the intracranial lesion; and finally, the ulcer developed malignant change. As far as we are able to ascertain this is the first case to be recorded of an ulcer with such a definite intracranial lesion which has ultimately developed a gastric carcinoma.

Case Report.—Hosp. No. A-3207: G. W., female, age 34, unmarried, was admitted to the Winnipeg General Hospital, in February, 1923, suffering from almost continuous occipital headaches, poor sight, loss of memory, irritability, and nervousness. She dated her illness back to April, 1922. Her first symptom was headache which became increasingly severe, awakening her at night. The headaches became progressively more severe, and in the summer of 1922 she started to have periodic attacks of vomiting. The vomiting was never projectile, and was preceded by nausea. In December, 1922, she was placed on a milk diet for five or six weeks, with relief of epigastric distress and nausea. Six months after the onset of the headaches she consulted an oculist because of failing vision.

Physical Examination showed dilated pupils reacting to light and accommodation, right nasal hemianopsia, and great reduction in the visual fields of both eyes. The disks were choked and there were retinal hemorrhages. Reflexes were all present and active, there were no changes in sensation, coordination was good, and there was no ataxia. A lumbar puncture at that time showed a pressure of 40 Mm.Hg. There was no abnormality in the spinal fluid. A roentgenogram of the skull showed partial absorption of the posterior clinoid process on the right side. At this time she became totally blind. Following ventriculography, there was vomiting of clear fluid, but no mention was made of epigastric pain or of blood in the vomitus. The ventriculogram suggested a midline shift of the third ventricle to the right, with no deformity of the lateral ventricles.

In April, 1923, the first craniotomy was performed by Dr. O. S. Waugh: The exploring needle encountered a firm, resistant mass in the suprasellar region at a depth

of about 6 cm. A left subtemporal decompression was accomplished. Following this there was marked improvement in her general condition, and her sight returned so that she was enabled to go on tour with a theatrical troupe.

Her second admission was in September, 1924. She now had repeated convulsions, with jerking movements of the left side of the body. Spinal fluid pressure was now 18 Mm.Hg. The original left-sided subtemporal decompression had completely filled in with bone. Bilateral subtemporal decompressions were now performed. There was a great tendency for these decompressions to regenerate bone and become solid. As they filled in, her symptoms returned. Finally, permanent openings were obtained, which resulted in a marked amelioration of her cranial symptoms.

Subsequent Course.—Although this patient had previously complained of epigastric distress following certain articles of diet, these symptoms were overshadowed by the neurologic manifestations. In October, 1929, however, she was readmitted to the hospital because of severe, constant epigastric pain, which had been present for one year, associated with flatulence, vomiting, and some loss of weight. Gastric analysis revealed no increase in free hydrochloric acid. A roentgenogram showed a perforating ulcer on the lesser curvature of the stomach near the cardia. In November, 1929, the ulcer was excised and it was reported by Dr. William Boyd as an innocent one.

In April, 1935, she was again admitted to the hospital, complaining of gaseous indigestion of three years' duration, and regurgitation of food. Roentgenograms showed hour-glass deformity but no ulcer crater. There was no improvement on a Sippy regimen; a posterior gastro-enterostomy was performed, which resulted in some improvement of her symptoms.

In October, 1937, she was again admitted to the hospital, complaining of epigastric pain two hours after meals, relieved by food. Gastric analysis was normal. Roentgenograms showed a large crater on the lesser curvature and an hour-glass deformity.

This patient came under observation first in July, 1938. The ulcer symptoms had increased, and the stools were positive for occult blood. There was no improvement with therapy which included a feeding jejunostomy. A large gastric ulcer on the lesser curvature proximal to the gastro-enterostomy stoma was demonstrated with the gastroscope. The patient went progressively downhill, vomiting, losing weight, and becoming very weak, until her death in October, 1938. For the last ten years her central nervous complaints had cleared up, apart from marked impairment of vision and occasional epileptic seizures which were readily controlled by luminal.

Autopsy.—The body was that of a small, extremely thin woman, 34 years of age. There was a deficiency in the skull in the temporoparietal region on each side. There were arachnoid adhesions in these areas. The brain showed no abnormality on the external surface. There was no evidence of increased intracranial pressure. On opening the brain, a rounded, firm tumor, 2.5 cm. in diameter, was found in the right frontal lobe immediately anterior to and encroaching on the anterior portion of the corpus callosum and the mesial surface of the lobe, and pushing the medial surface of the frontal lobe across the median plane to the left. It was invading the junction of the body and the anterior horn of the lateral ventricle. It passed down through the corpus callosum, encroaching on the septum lucidum, fornix, and the head of the caudate nucleus. The lamina terminalis of the third ventricle was compressed. The inferior horn of the lateral ventricle was dilated. On section, the tumor was firm, smooth, and pinkish in color, with irregular cystic spaces. Microscopically, it was a fibrillary astrocytoma.

There were numerous dense adhesions in the upper abdomen. The stomach showed a large ulcer on the lesser curvature and anterior wall, 2 cm. in diameter. It was sharply defined with a smooth base and rounded edges. There were no enlarged lymph nodes. Microscopically, the picture was that of a very chronic peptic ulcer with malignant changes at one edge. The epithelial cells here were of the signet-ring type, and there was mucin in the stoma. No metastases were found in any of the organs.

FIG. 2.—The tumor in the right frontal lobe pressing on the genu of the corpus callosum.

FIG. 3.—Showing the deepest portion of the tumor encroaching on the fornix and lateral ventricle.

FIG. 4.—Showing the large ulcer on the lesser curvature and anterior wall.

SUMMARY

A striking case is recorded of a woman who suffered from an intracranial tumor in 1923, and who developed a gastric ulcer which recurred on several occasions, after various forms of medical and surgical treatment. At autopsy, a fibrillary astrocytoma was found in the right frontal lobe encroaching on the corpus callosum, the lateral ventricle, septum lucidum, fornix and lamina terminalis of the third ventricle. The ulcer showed beginning malignant change.

BIBLIOGRAPHY

[1] Hall, G. E.: Excerpts from Experimental Heart Disease. Read before Am. College of Physicians, April 5, 1938.

[2] Hall, G. E., Ettinger, G. H., and Banting, F. G.: Experimental Production of Coronary Thrombosis and Myocardial Failure. Canad. Med. Assn. Jour., 34, 1936.

[3] Manning, G. W., Hall, G. E., and Banting, F. G.: Vagus Stimulation and the Production of Myocardial Failure. Canad. Med. Assn. Jour., 37, 314–318, 1937.

[4] Ettinger, G. H., Hall, G. E., and Banting, F. G.: Effects of Repeated and Prolonged Stimulation of the Vagus Nerve in the Dog. Canad. Med. Assn. Jour., 35, 27–31, 1936.

[5] Mogilnitsky, B. N.: Zur Frage der Enterstehungsweise und Ursache Neurogener Formen des Runden Magenschwuers. Arch. f. path. Anat., 257, 109–118, 1925.

[6] Burdenko, N., and Mogilnitsky, B. N.: Zur Pathogenese Einiger Formen des runden Magen-Darmgeschwuers. Ztschr. f. Neurol. u. Psychiat., 103, 42–62, 1926.

[7] Cushing, H.: The Reaction to Posterior Pituitary Extract (Pituitrin) When Introduced into the Cerebral Ventricles, *etc.* Proc. Nat. Acad. Sci., 17, 163–180; 239–264, 1931.

[8] Cushing, H.: Peptic Ulcers and the Interbrain. Surg., Gynec., and Obstet., 55, 1–33, 1932.

[9] Hoffmann, C. E. E.: Über die Erweichung und den Durchbruch der Speiseroehre und des Magens. Arch. f. path. Anat., 44, 352–365, 1868.

[10] Arndt, R.: Ein Tumor Cerebri. Arch. f. Psychiat., 4, 432–464, 1874.

[11] Von Winiwarter, J. R.: Über Magen-Darmblutungen nach Operationen. Arch. f. klin. Chir., 95, 161–184, 1911.

[12] Beneke, R.: Über die haemorrhagischen Erosionen des Magens (Stigmata ventriculi). Verhandl. d. deutsch. path. Gesellsch., 12, 284–294, 1908.

[13] Von Preuschen, F.: Verletzungen des Kindes bei der Geburt als Ursache der Melaena neonatorum. (Klinische u. experimentelle.) Festschr. z. Feier d. 50 jaehrigen Jubilaeums d. Gesellsch. f. Geburtsh. u. Gynaek. in Berlin. Pp. 359–419. Vienna: Alfred Holder, 1894.

[14] Pomorski, J.: Experimentelles zur Aetiologie der Melaena neonatorum. Arch. f. Kinderh., 14, 165–193, 1892.

[15] Schiff, M.: De vi motoria baseos encephali inquisitiones experimentales. Pp. 54. Bockenheim (Frankfurt a.M.), 1845.

[16] Ebstein, W.: Experimentelle Untersuchungen Über das Zustandekommen von Blutextravasaten in der Magenschleimhaut. Arch. f. exper. Path. u. Pharmakol., 2, 183–195, 1874.

[17] Eppinger, H., and Hess, L.: Nervous and Mental Disease Monograph Series, No. 20, 2d ed. New York, 1917.

[18] Westphal, K.: Untersuchungen zur Frage der nervoesen Entstehung peptischer Ulcera. Deutsch. Arch. f. klin. Med., 114, 327–395, 1914.

[19] Light, R. U., Bishop, C. C., and Kendall, L. G.: Production of Gastric Lesions in Rabbits by Injection of Small Amounts of Pilocarpine in the Cerebrospinal Fluid. Jour. Pharmacol. and Exper. Therap., 1932 (in press).

[20] Blackfan, K. D.: Quoted by Cushing.[8]

GIANT DIVERTICULUM OR DUPLICATION OF THE INTESTINE WITH RECURRENT PERFORATIONS

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A LARGE GROUP of anomalies consisting of cysts and diverticula whose walls show the same histologic structure as the alimentary tract may, for the sake of simplicity, be regarded as duplications of the alimentary tract. They are possibly the results of abortive attempts at twinning, or they may have had their origin in the so-called "nodules of Lewis and Thyng."[8] This group, however, must be differentiated from the true Meckel's diverticulum.

The indiscriminate use of the term "Meckel's diverticulum," as applied to all diverticula of the lower ileum, is an unfortunate custom. It is true that most diverticula found in this region are situated on the antimesenteric border of the intestine and probably *are* the unobliterated remnants of the vitelline duct, thus fitting appropriately Meckel's[1] original description. There are some diverticula, however, usually but not always of the lower ileum, which are located on the opposite side of the intestine, lying wholly or in part between the leaves of the mesentery; and it seems certain that these have an entirely different origin. They are, undoubtedly, congenital, since they often give rise to symptoms early in life, have structure similar to that of the intestinal tract, and show evidences of heterotopia. They are often very large, and may cause serious symptoms. Many, however, are symptomless, as shown by their incidental discovery at operation or autopsy.

The following case is reported because of its unusual and dramatic clinical features, and because it contributes forcible evidence to the view that such intramesenteric diverticula are not Meckelian in origin.

Case Report.—E. A. M., a white, female child, three and one-half years old, was brought by her parents to the hospital in Shawnee, Oklahoma, August 29, 1938, consulting Dr. F. L. Carson. She was acutely ill, suffering from severe generalized abdominal pain, which had begun suddenly on the preceding evening, and had been accompanied by frequent vomiting. For the three days preceding the onset of pain and vomiting, she had passed numerous black tarry stools, and had become weak and pale.

It was recalled that, at the age of six weeks, she began to pass tarry stools and to cry, as if in abdominal pain. This episode lasted six weeks, after which she was well until the age of 18 months, when she developed a purpuric eruption over the body and lower extremities. After blood transfusion, the eruption disappeared and she remained well until the present illness, although somewhat frail and underweight. Both parents and an older sister were normal and healthy.

Physical Examination.—The patient presented the picture of shock, with extreme pallor, cold skin, rapid, thready pulse, and a diffusely tender abdomen, rigid in the lower half, where an indistinct mass could be felt. Blood count showed hemoglobin 40 per cent; red cells, 2,500,000. Urine was normal. *Clinical Diagnosis:* Peptic ulcer of Meckel's diverticulum with perforation.

Submitted for publication August 27, 1939.

Because of the dangerous general condition, supportive treatment was administered, including a blood transfusion, and operation delayed until the following day.

First Operation.—August 30, 1938: Doctor Carson. Under ether anesthesia, a low right rectus incision was made; and, when the peritoneum was opened, a gush of bloody fluid and gas was encountered. There were extensive fibrinous adhesions everywhere, but rapid exploration revealed the site of a perforation in the ileum near the ileocecal valve, as well as could be determined. There was no well-developed diverticulum seen, but a definite bulge of the antimesenteric border of the ileum, with the perforation at its apex, was found. The fluid contents of the abdomen were aspirated; the perforation

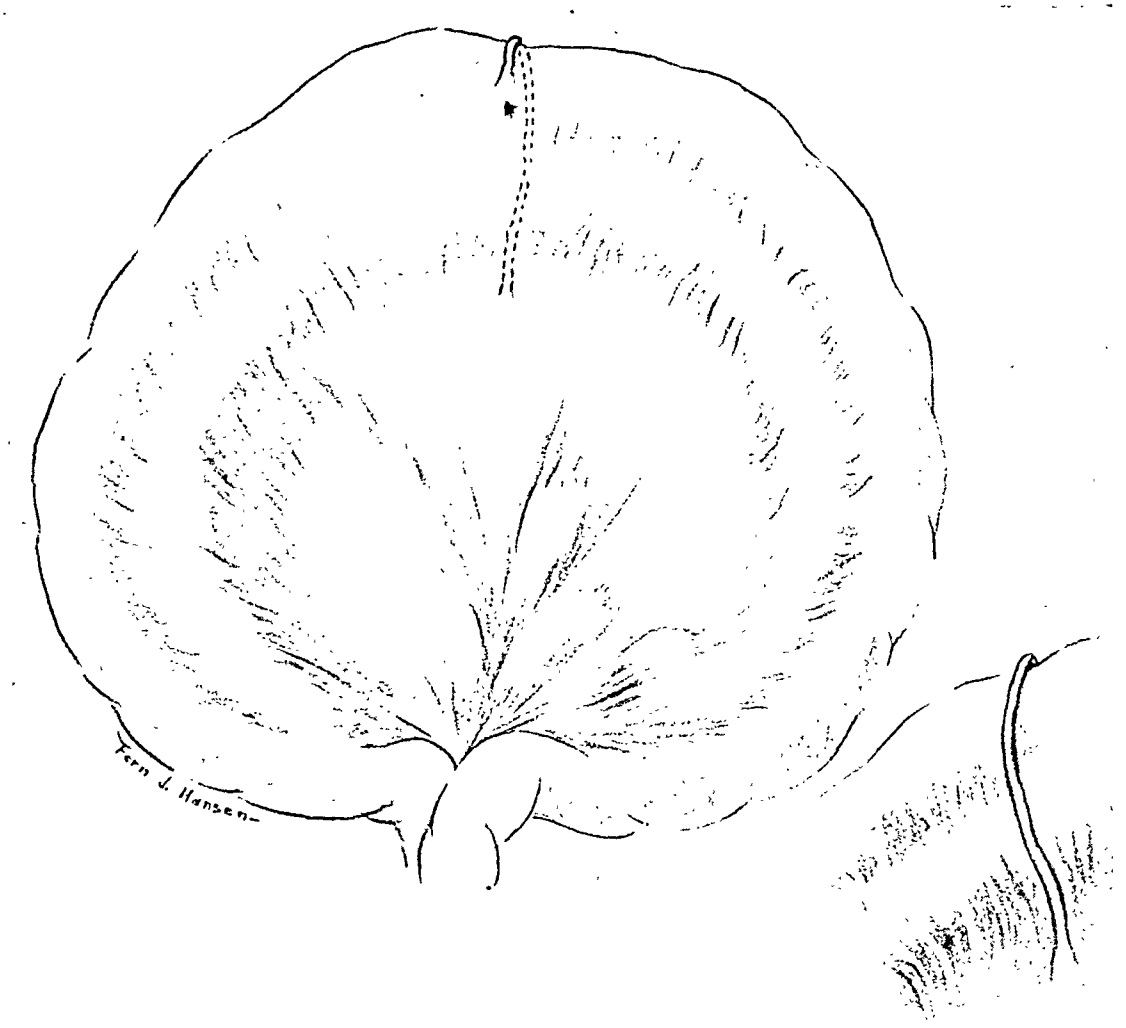


FIG. 1.—Drawing of diverticulum and adjoining ileum as seen at second operation. The perforation is shown near the base of the fibrous remnant of the omphalomesenteric duct.

closed with a purse-string suture; and the wound closed in layers, with one cigarette drain inserted.

After a stormy convalescence, the child recovered and the wound was healed in about four weeks. Stools became normal in appearance. Appetite improved and she began gaining weight.

On November 24, 1938, three months later, while the patient and her parents were visiting in Dallas, Texas, she became suddenly ill again with severe pain in the lower abdomen, followed by vomiting and circulatory collapse. The parents recognized the signs as a recurrence of the previous catastrophe and promptly called Dr. G. L. Hacker, who had her taken to the Baylor University Hospital. The abdomen was again found

to be rigid and the diagnosis not to be doubted, but treatment for shock was imperative before operation could be attempted. After administering morphine sulfate gr. 1/16 and adrenalin chloride solution 0.5 cc., followed by 5 per cent glucose, 200 cc., intravenously, and a transfusion of citrated blood, 200 cc., the child's condition improved; and operation was performed about six hours after onset of symptoms. Hemoglobin 48.6 per cent; R.B.C. 2,760,000; W.B.C. 16,650; bands 30 per cent; segmented neutrophils 46 per cent. Urinalysis: Specific gravity 1.028, acid, albumin trace, acetone 4 plus.



FIG. 2.—Photomicrograph of section at edge of perforated ulcer, showing characteristic intestinal mucosa.

Second Operation.—November 25, 1938: Doctor Duckett. Under ethylene and ether anesthesia, a suprapubic midline incision was made. There was again peritonitis present, and a perforation in the ileum, but this time on the lateral wall. It could now be seen that no ordinary Meckel's diverticulum was present, but between the leaves of the mesentery, and lying parallel to the ileum, was an elongated diverticulum or reduplication of the ileum. This tube-like structure was approximately 30 cm. long, of about the same diameter as the adjacent intestine and, at its midpoint, communicated through a wide opening with the lumen of the intestine exactly at the site of perforation. Near the antimesenteric border of the ileum, close to the perforation, originated a fibrous cord, 5 Mm. in diameter, which looped over and behind the ileum to be attached at its other end to the base of the mesentery on the opposite side (Fig. 1).

It was apparent that removal of the diverticulum would be impossible without great risk to the child's life. Resection of the diverticulum, because of its close proximity to the ileum, would have undoubtedly jeopardized the blood supply of the ileum. Resection of the diverticulum and ileum was too extensive a procedure for the child to tolerate under the existing circumstances. Closure of the perforation was the only recourse, but this proved to be a difficult problem because of the thickness and friability of the wall at the junction of the ileum and diverticulum. Because of the ample space provided, and the large opening between ileum and diverticulum, an elliptical excision of the perforated ulcer was made, leaving fairly normal intestinal wall at the sides of the defect, which were sutured together with inverting mattress sutures of fine chromic catgut. The fibrous cord, previously described, was also removed with this section of the ileal wall, being cut at

its point of attachment to the mesentery. The fluid contents of the abdomen were aspirated, and the wound closed in layers without drains.

A very satisfactory postoperative course followed and, after several transfusions, the child left the hospital on the tenth postoperative day. Blood count: Hemoglobin 107 per cent; R.B.C. 5,700,000. Stools showed a few red blood cells only.

Pathologic Examination.—Microscopic: "The bowel wall shows a mucosa which contains numerous slightly tortuous tubular glands lined by simple columnar epithelium of the goblet cell type. In some areas, these glands appear distorted. The stroma between these glands contains a diffuse infiltration of plasma cells, eosinophils, lymphoid cells, and occasional polymorphonuclear neutrophils (Fig. 2). The submucosa contains a similar type of exudate.

"At one point, there is an ulceration extending through the entire bowel wall. Adjacent to this area of ulceration, there is dense fibrous tissue in all layers of the wall, most marked in the subserous layer. The superficial layers are necrotic and contain much fibrin. On the outer surface of the adjacent bowel wall, there are many polymorphonuclear neutrophils in various stages of disintegration. A large amount of fibrin is also present and tissues stain poorly with a granular appearance. No gastric mucosa is seen.

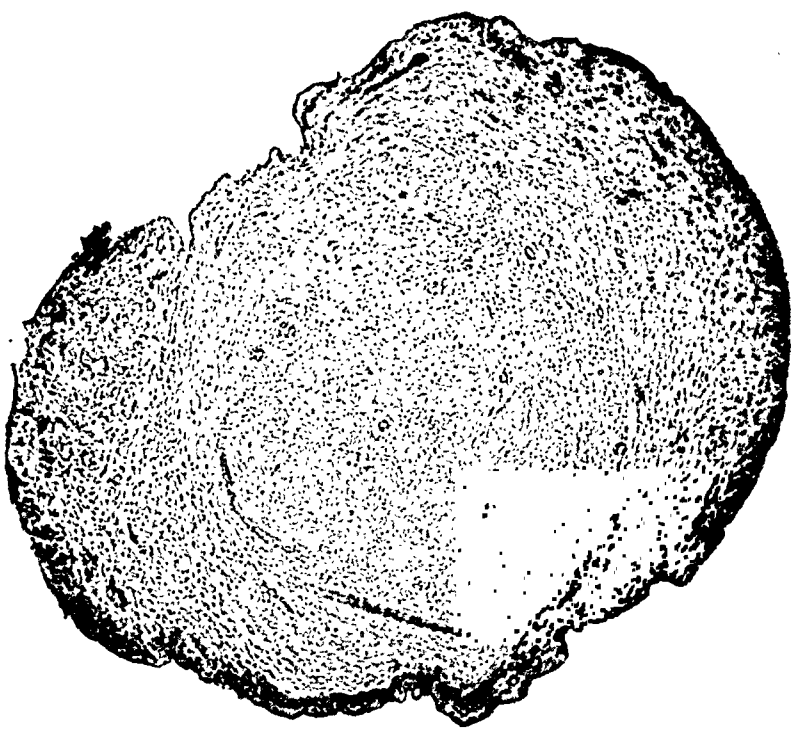


FIG. 3.—Photomicrograph of section of fibrous remnant of omphalomesenteric duct.

"Sections of the cord-like structure show dense fibrous tissue with a few plasma cells and lymphoid cells, and a few small thick-walled blood vessels (Fig. 3). *Pathologic Diagnosis:* Acute inflammation in a chronic ulcer at junction of ileum and bifurcated diverticulum. Acute necrotizing peritonitis."

The child was allowed to go to her home in Oklahoma for convalescence, but it was planned for her to return to Dallas after six to eight weeks for resection of the diverticulum, if her condition was favorable. After two weeks at home, however, she began to have recurrence of abdominal pain and tarry stools, both of which were of daily occurrence. She was, consequently, brought back to Dallas and readmitted to Baylor University Hospital, January 4, 1939, for operation. Temperature 101° F., pulse 100, respirations

26. Hemoglobin 72 per cent; R.B.C. 4,350,000; W.B.C. 11,900, bands 33 per cent, segmented neutrophils 38 per cent. Urine was normal.

Third Operation.—January 5, 1939: Doctor Duckett. Under nitrous oxide–ethylene-ether anesthesia, the scar of the previous low right rectus incision was excised and the peritoneum opened. The loop of ileum with the adjoining diverticulum, previously described, was easily located and delivered through the wound. The wound in the intestine and diverticulum made at the previous operation was well healed but there was some constriction of the ileum at this point. There were signs of a low grade peritonitis, all

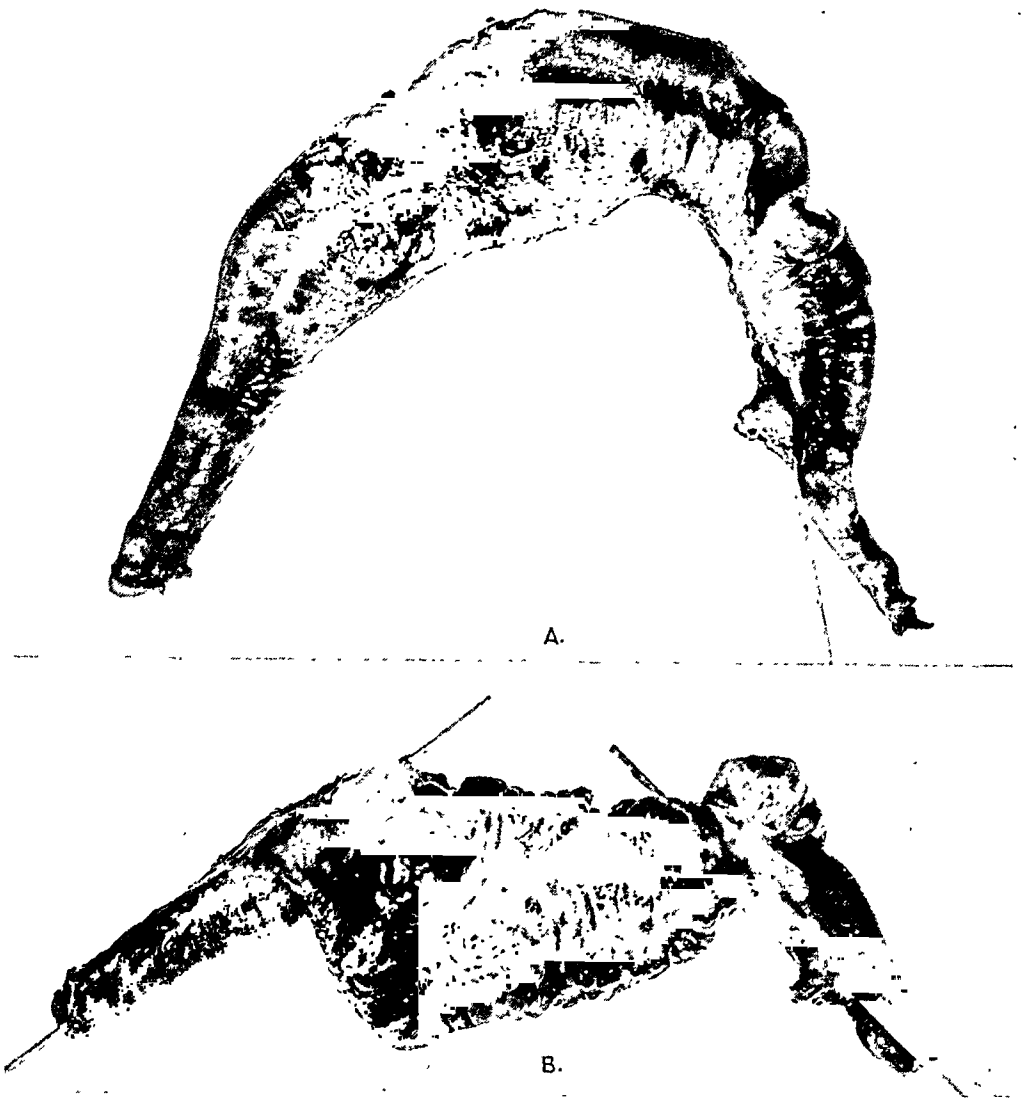


FIG. 4.—Photograph of resected diverticulum and adjoining ileum: (A) intact, (B) opened at middle orifice.

peritoneal surfaces being moderately red and edematous and, in the mesentery common to the diverticulum and ileum, there were a number of large, firm lymph nodes, the largest measuring 2x1.5 cm. The ileum was traced distally to the ileocecal valve, a distance of 50 cm., where the appendix was inspected and found normal in appearance. It was not removed.

Using a Furniss intestinal anastomosis clamp, a length of ileum 42 cm. long was resected, together with the attached diverticulum and a V-shaped section of mesentery,

including most of the enlarged lymph nodes (Fig. 4). At the proximal end of the diverticulum, the tip was severed and about 1 cm. of the diverticulum was left at the base of the mesentery where its removal might have caused injury to large blood vessels. The mucosa of this tip was completely removed, however. An end-to-end anastomosis was performed over the pin of the Furniss clamp, using a continuous suture of No. 0 chromic catgut reenforced by an overlying row of black silk mattress sutures. The wound was closed in layers without drains.

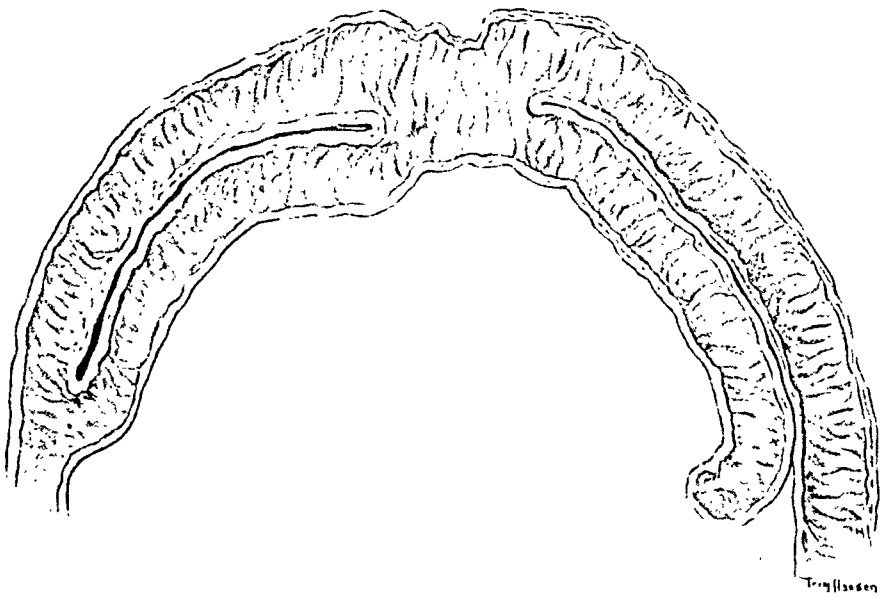


FIG. 5.—Drawing of diverticulum and adjoining ileum to show communicating openings and small ulcer of the mucosa of the ileum.

Shortly after operation, abdominal distention and vomiting developed, which were, however, relieved by the Wangensteen duodenal suction, which was used for three days. One blood transfusion was administered, in addition to glucose, sodium lactate, and Hartmann's solution intravenously and subcutaneously. On the fifth postoperative day, toast, crackers, and gelatin were well tolerated and, from then on, convalescence was rapid and uneventful. She was discharged, January 19, 1939, 14 days after operation, with the wound healed. Hemoglobin 83 per cent; R.B.C. 4,350,000. Urine normal. There was no blood in the stools.

Pathologic Examination.—Gross: "The specimen consists of 42 cm. of ileum with attached section of mesentery between the leaves of which is a diverticulum 27 cm. long. This diverticulum lies close against the lesser curvature of the resected loop of ileum, and communicates with the ileum both at the middle and at the distal end of the diverticulum. In the fused wall of ileum and diverticulum, at the middle site of communication, is a depressed scar of a previous surgical incision about 4 cm. long (Fig. 5).

"When the walls of the specimens were incised, both ileum and diverticulum were found lined with apparently normal mucosa except for a shallow ulceration in the mucosa of the ileum immediately adjoining the communicating opening at the middle of the diverticulum.

"There was no gross blood found in either lumen. The mucoid secretion in the diverticulum was washed out with a small quantity of distilled water, and was found to have an acidity of 5°.

"Microscopic Study.—Dr. George T. Caldwell, Pathologist-in-Chief: Sections taken from multiple areas in the walls of the ileal segment, and from the diverticulum, showed the ileum to be lined with normal intestinal mucosa, and the diverticulum with normal

gastric mucosa (Figs. 6 and 7). No pancreatic or other aberrant tissues were found, although careful search was made for these anomalies."

Since her last operation, the child has gained weight and strength continuously. She has had three attacks of moderately severe lower abdominal pain, once accompanied by nausea and vomiting, but each attack lasted only a few hours. There has been no return of tarry stools, and a specimen of stool examined May 27, 1939, showed no blood. A gastro-intestinal series, May 26, 1939, showed no sign of obstruction or other abnormality in the stomach or intestines. Barium was seen in large quantity in the cecum four hours after taking the meal. Hemoglobin 75 per cent; R.B.C. 3,750,000.

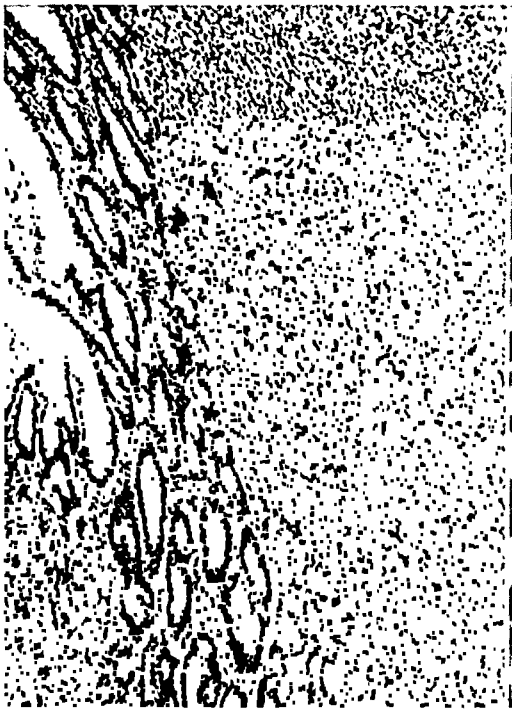


FIG. 6.—Photomicrograph of section of gastric mucosa lining the diverticulum. (Low power)



FIG. 7.—Higher magnification of section shown in Figure 6. Note characteristic gastric glands with parietal cells.

COMMENT.—This case is of unusual clinical interest for a number of reasons: The seriousness of the problem offered by such a giant diverticulum is evidenced by the fact that the reports of only six similar cases, successfully operated upon, have been found. Positive diagnosis in the past has been extremely difficult but should be more frequently made since now it is generally recognized that many diverticula contain heterotopic gastric mucosa associated with ulceration and that when this condition is present blood in the stools is a constant finding. Stools are usually tarry but the blood may be fresh, and rectal polypi or other rectal disease must be eliminated as a source of the bleeding. Since this type of diverticulum is always congenital, bleeding from the rectum usually begins in infancy. When perforation of an ulcer in or associated with a diverticulum occurs, the diagnosis is practically unmistakable. Perforation of a gastric or duodenal ulcer may be differentiated by location of the pain in the upper abdomen, and perforation of a typhoid ulcer by recognition of the preceding characteristic febrile illness.

It is further significant that the true nature of the diverticulum was not discovered at the first operation. This was probably accounted for by the fact that the patient's condition was extremely precarious and haste was an essential factor in the success of the operation. The intramesenteric location of the diverticulum made it difficult to recognize, however; and, even if haste had not been necessary, it might easily have been overlooked. Hudson[13] calls attention to this fact in his discussion of giant diverticula, stating that, during the operation upon one of his patients, nearby spectators could see the diverticulum only indistinctly after it was pointed out to them. This emphasizes the necessity for very careful inspection, not only of the intestine itself but also of the mesentery, during exploration to ascertain the etiology of obscure abdominal symptoms.

The technical problem involved in removing a giant intramesenteric diverticulum may present considerable difficulty. Abt and Strauss[2] were able to resect a diverticulum 18 inches long without removal of the adjoining ileum. They state that in their case the blood vessels of the diverticulum were separate and parallel to those supplying the ileum, but in most cases there has been a blood supply common to both, the vessels normally supplying the ileum merely sending off branches to the diverticulum in passing to either side of it. Close apposition of the wall of the diverticulum to that of the intestine may make their separation impossible. The size of the opening between diverticulum and intestine may be too great to allow adequate closure of the defect remaining in the intestinal wall after resection of the diverticulum. All of these factors may be present, as in the case reported herewith; and, consequently, resection of a length of intestine with the diverticulum may be necessary. If at all possible, primary anastomosis, preferably end-to-end, should be performed. These children tolerate very poorly the loss of fluid and the necessity for multiple operative procedure following double-barreled enterostomy. Normark[3] points out that the only operative cases which have recovered were those in which one-stage resection and entero-anastomosis were performed.

In addition to the features of clinical interest, this case is of significance in shedding further light on the probable origin of such intramesenteric diverticula. Since the vitelline duct is an outgrowth of the primitive intestine on the antimesenteric border, it is difficult to consider a structure lying within the leaves of the mesentery as being derived from the duct. Furthermore, in this case, a cord-like structure was found attached at one end to the wall of the ileum near its antimesenteric border, and at its other end to the base of the mesentery. Such cords have been found attached as terminal filaments to the ends of typical Meckel's diverticula. The distal end of the cord may be free, attached at the umbilicus, or attached to the mesentery or other abdominal organ. Cords, similar to this one, have also been described as occurring without diverticula, but from their structure and location are generally regarded as remnants of the vitelline duct and omphalomesenteric blood vessels. It is impossible for two vitelline ducts to occur in the same individual;

hence, the presence of the cord-like remains of the duct and vessels on one side of the intestine make it necessary to assign another mode of origin to the diverticulum on the other side. Similar evidence is found in the case reported by Edwards.[4] A small, but typical Meckel's diverticulum was discovered on the resected intestine and, in addition, an adjoining giant intramesenteric diverticulum. The patient survived.

Using his findings as a basis, Edwards discussed at length the etiology of congenital diverticula of the intestine. He stated that the great majority of congenital diverticula are Meckel's diverticula, but there is a small remaining group whose etiology differs from those of the Meckelian type "in that, whereas Meckel's diverticula result from an arrest of normal development, the others arise as a result of abnormal development." He considers giant diverticula to be true reduplications of the bowel, and to "represent an attempt at the formation of a twin, which has come at a comparatively late stage of development of the ovum, so that the extent of reduplication is limited to a segment of the bowel." Webster,[5] reporting a "Giant Diverticulum (Reduplication) of the Colon" in a child, who also had accessory fingers and toes, suggests that the simultaneous occurrence of these abnormalities indicates that both phenomena represent a mistimed or belated attempt at formation of a twin.

Evans,[6] however, presents strong arguments in favor of another explanation for the development of cysts and diverticula of enterogenous origin, but not of the true Meckel's type. He recalls attention to the "nodules of Lewis and Thyng." These are outgrowths of epithelium from the primitive intestinal canal first described by Keibel,[7] in 1905, but more fully by Lewis and Thyng,[8] in 1907–8. These nodules were found consistently in sections of rabbit, pig, and human embryos. Some were seen to have become vacuolated and to form either cysts or diverticula, depending on whether or not they communicated with the intestinal lumen. In later embryos, the nodules, cysts, and diverticula were scarce or absent, indicating that they became absorbed or coalesced with the developing intestine. Persistence of these primitive cysts and diverticula could readily account for many of the cysts and diverticula found associated with the intestinal tract after birth. Further support for this view is the finding of an intramesenteric diverticulum of the intestine and a mediastinal cyst in the same individual, both diverticulum and cyst having structures typical of the intestinal tract. Such cases have been reported by Roth,[9] Moll,[10] Poucher and Milles,[11] and Black and Benjamin.[12] The statement has been made that the observations of Lewis and Thyng have not been confirmed. Since this seemed strange, the writer obtained serial sections of a 6 Mm. human embryo from the Embryology Laboratory of the Baylor Medical School, and, on examination of these sections, three diverticula similar to those described by these investigators were easily identified. The accompanying reproduction of a photomicrograph shows two of these diverticula at the same level in the small intestine (Fig. 8). Since they are thus readily found, it would seem that the nodules of Lewis and Thyng are

quite real, and offer a satisfactory and logical explanation for the origin of diverticula other than Meckel's.

Hudson,[13] in 1935, published a review of the subject entitled "Giant Diverticula or Reduplications of the Intestinal Tract" with a complete bibliography. He found 18 cases previously reported, and added three. W. E. Ladd,[14] in 1937, reviews the more inclusive subject of enterogenous cysts and diverticula, grouping them together under the term "Duplications of the Alimentary Tract." In order to simplify the confused nomenclature of these conditions, Doctor Ladd refers to them as "cystic duplications," regardless of whether or not the lumen of the anomalous structure has one or more connections with the lumen of the alimentary tract. The essential feature, he



FIG. 8.—Photomicrograph of section of 6 Mm. human embryo showing two diverticula connected with the primitive small intestine. These out-pouchings were traced through adjacent sections in the series and proved, without doubt, to be diverticula.

believes, is the similarity in structure of the walls. Three of his cases, requiring resection and anastomosis, survived.

Until more definite evidence is obtained as to their exact mode of origin, it seems logical to consider these structures as duplications of the alimentary tract. It is entirely a matter of conjecture as to whether they arise from the "nodules of Lewis and Thyng" or whether they are examples of "twinning." In describing these duplications, however, it is necessary to distinguish between cysts and diverticula, since the clinical problems which they present are usually quite different and characteristic.

In addition to the cases from the Boston Children's Hospital reported by Ladd[14] and by Hudson,[13] recent publications contain several similar cases of interest. The one described by Abt and Strauss[2] is unique in that the diverticulum, in an 11-month-old boy, although situated entirely between the leaves of the mesentery, had a separate blood supply, its vessels being parallel to

those supplying the ileum beyond it. The diverticulum was successfully resected without damage to the ileum or its blood supply. The mucosa of the diverticulum showed characteristic structure of intestinal mucous membrane, and there were no ulcerations.

Black and Benjamin[12] in 1936, reported the autopsy findings in an infant five and one-half months old, which included an enterogenous intestinal pouch or diverticulum, 10 cm. long, lying between the leaves of the mesentery of the jejunum and partly fused with the jejunum. This pouch had two orifices, one near each end, which communicated with the intestine. There was a perforating peptic ulcer near the proximal orifice but no mention is made of gastric mucosa being found in the diverticulum. There was also a large retromediastinal enterogenous cyst attached to the thoracic vertebrae. The child had tarry stools for ten days before death.

A giant diverticulum in a five-year-old girl was reported from the Mayo Clinic, first by Dixon and Famiglietti,[15] in 1937, and later by Goldstein and Cragg,[16] in 1938. This diverticulum was 61 cm. long; it contained gastric mucosa and a typical peptic ulcer. The diverticulum and ileum were described as having a common mesentery. The diverticulum joined the ileum at the mesenteric border, and its distal end was buried in the mesentery. The child had tarry stools from the age of six months, and abdominal pain from the age of two years. Operation resulted fatally.

Harild,[17] in 1937, reported a three-year-old boy who died from peritonitis following perforation of an ulcer of the ileum. The ulcer was situated 1 Mm. from the opening of an intramesenteric diverticulum, 50 cm. long, which was lined with gastric mucosa. This child also had bloody and tarry stools after the age of seven months.

Normark,[3] from Upsala, Sweden, in 1938, described a successful operative case of an intramesenteric diverticulum in a two-year-old boy who had tarry stools after the age of two and one-half months. There had also been occasional nausea and vomiting, and once severe abdominal pain. At operation, an intramesenteric small bowel diverticulum, 15 cm. long, was found, which was lined with gastric mucosa. In the ileum, near the mouth of the diverticulum, was a typical peptic ulcer. Resection of diverticulum and adjoining ileum was performed, with recovery.

SUMMARY AND CONCLUSIONS

Report is made of a child successfully operated upon twice for closure of perforations in the small intestine, and a third time for resection of 42 cm. of ileum, together with an intramesenteric giant diverticulum (duplication) 27 cm. long. The diverticulum was lined with gastric mucosa, and the perforations occurred in typical peptic ulcers adjoining one of the two openings between the diverticulum and the intestine.

The unusual clinical features of the case are discussed with special reference to diagnosis, difficulties encountered in recognizing intramesenteric diverticula at operation, and technical problems in removal of such diverticula.

The findings in this case indicate that such anomalies are not true Meckel's diverticula, but probably develop from the intestinal epithelial nodules found by Lewis and Thyng in early animal and human embryos. The writer's study of serial sections of a 6 Mm. human embryo showed three such primitive diverticula.

The use of the term "duplications of the alimentary tract," in referring to the entire group of enterogenous cysts and diverticula, obviously not of Meckelian origin, is advocated.

REFERENCES

[1] Meckel, J. F.: Arch. f. a. Physiol., 9, 439, 1809.
[2] Abt, I. A., and Strauss, A. A.: J.A.M.A., 87, 991, September 25, 1926.
[3] Normark, A.: Acta Pediat., 20, 475, 1938.
[4] Edwards, H.: Brit. Jour. Surg., 17, 7, 1929.
[5] Webster, R.: Med. Jour., Australia, 25, 1061, June 18, 1938.
[6] Evans, A.: Brit. Jour. Surg., 17, 34, 1929.
[7] Keibel: Verhandl. d. anat. Gesell, Erg. Heft zu anat. Anz., 27, 39, 1905.
[8] Lewis and Thyng: Amer. Jour. Anat., 7, 505, 1907-8.
[9] Roth: Virchow's Archives, 86, 371, 1881.
[10] Moll: Brit. Jour. Surg., 14, 176, 1926.
[11] Poucher, H. G., and Milles, G.: Am. Jour. Dis. Child., 45, 1064, 1933.
[12] Black, R. A., and Benjamin, E. L.: Am. Jour. Dis. Child., 51, 1126, 1936.
[13] Hudson, H.: New England Jour. of Med., 213, 1123, December 5, 1935.
[14] Ladd, W. E.: South. Med. Jour., 30, 363, 1937.
[15] Dixon, C. F., and Famiglietti, E. V.: Proc. Staff Meet., Mayo Clin., 12, No. 35, September 1, 1937.
[16] Goldstein, M., and Cragg, R. W.: Am. Jour. Dis. Child., 55, 128, 1938.
[17] Harild, S.: Acta chir. Scandinav., 80, 181, 1937–38.

TOPOGRAPHY AND DEVELOPMENT OF THE CECUM-APPENDIX

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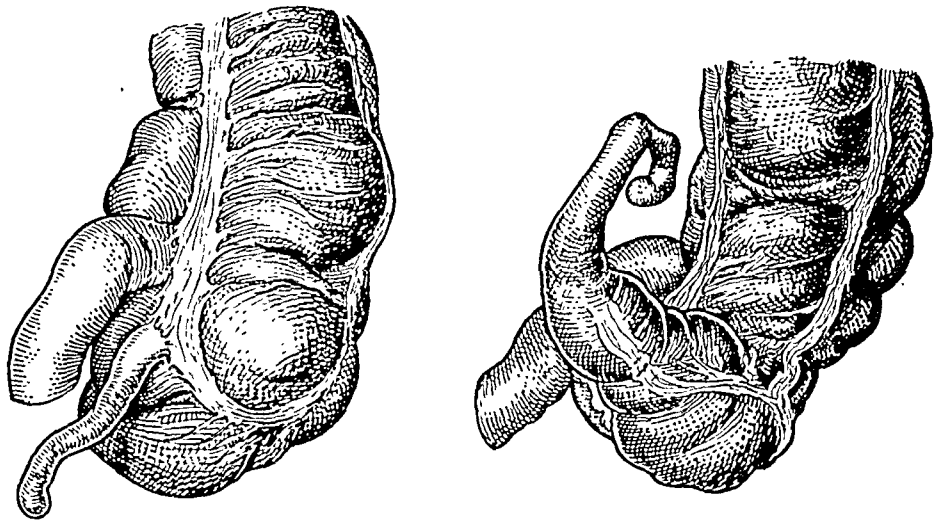
THE APPENDIX is said to be the only organ in the body which has no normal position (Maingot[1]). A valid objection to this statement concerns the restrictive word *only*. Other abdominal viscera such as the stomach, jejuno-ileum, transverse colon and sigmoid are variously more mobile than the appendix, and in the living subject, as seen by roentgenographic silhouettes of induced opacities, these organs are very diverse in position, not only from one individual to another but also in the same individual at different times under different degrees of filling and under other changing physiologic conditions. However, Maingot's statement is of value in emphasizing the fact that the appendix is frequently one of the mobile viscera, even though its lack of normal position is not in itself remarkable.

Contours of the Cecum.—Where the appendix is at any given time depends largely on the cecum; and the cecum in turn is subject to wide fluctuations of contour and to some change of position as a result of tonus, peristaltic activity and contents. The contours of filled and empty ceca and the effect of these states on the appendix are well shown in Figs. 1 A and B. These represent the usual or so-called normal ceca viewed from behind, this view showing better than any other the convergence of the three taeniae coli at the root of the appendix. It is seen that with the cecum distended (Fig. 1 A) the appendix has a dependent position, while with the cecum contracted (Fig. 1 B) the appendix is turned sharply upward in a retrocecal position.

It may be objected that the two specimens placed in juxtaposition (Fig. 1) are simply two different types of ceca, or at any rate ceca taken from two different cadavers. This latter objection is of course valid as far as cadaver anatomy goes. These are, indeed, two different specimens, with the peritoneum removed in each case to show more clearly the course and termination of the taeniae coli. Yet from a comparison of these specimens certain deductions may be made regarding the effects of contraction on the cecum and appendix. In Fig. 1 B it is seen that the apparent root of the appendix is much enlarged, as if cecal contents had been forced into it. But this is not at all the case, for the reason that the apparent root of the appendix is, in fact, the appendicular zone of the cecum itself with its musculature strongly contracted; one of the taeniae is clearly visible over this bulbar enlargement. The musculature of the appendix is also contracted; the longitudinal muscle, as a continuous tunic formed by convergence of the taeniae, has shortened and kinked the appendix.

Submitted for publication August 29, 1939.

Peristalsis and the Ileocecal Valve.—The foregoing comparison of distended and contracted ceca calls for a brief consideration of the movements of the large intestine, especially as they affect the ascending colon and cecum. Cannon,[2] studying movements of the large intestine in the cat roentgenologically, found that in the distal transverse and descending colons the contents



A B

FIG. 1.—The cecum-appendix viewed from behind. (A) Cecum distended and appendix directed downward. (B) Cecum contracted and appendix turned upward. In both specimens the peritoneum has been removed to demonstrate more clearly the taeniae coli. (Redrawn from Spalteholz.)

are moved toward the rectum by peristaltic waves, but in the ascending and proximal transverse colons the more frequent movement is antiperistaltic. The contents in these parts are liquid and set up running waves of contraction toward the ileocecal valve, such waves being separated by long periods of rest. Cannon's assumption is that the ileocecal valve prevents return of cecal contents to the ileum.

Hurst[3] and others, from roentgenologic examinations in men, find a different type of movement which they call "mass peristalsis," *i.e.*, strong but brief movements of contents from one part of the large bowel to the next, such movements being connected with the act of eating by an alleged gastrocolic reflex set up by entrance of food into the stomach. Contents are said to traverse the colon at long intervals by sudden displacements due to the "mass peristalsis." In latent periods the only activity is that of "haustral churning," whereby the contents are subject to local, nonprogressive agitation from contraction of the haustra.

While roentgenographic methods are the only ones affording a direct visual study of normal intestinal movements, it is obviously difficult to employ such methods on the large intestine where rest periods are so lengthy. In this connection, one traditional view must be corrected with emphasis: The ileocecal valve is not, in a strict functional sense, a valve to prevent return of cecal contents into the ileum, nor is such return prevented by the so-called ileocecal sphincter. This assertion is based upon the repeated experience of clinical roentgenologists, who find that when the entire large intestine is filled

with a barium enema a variable length of terminal ileum usually appears in the roentgenogram.

Effects of Growth and Gravity on the Cecum-Appendix.—Another factor seldom fully considered in the literature is that of gravity as it operates on the several parts of the large intestine. With an individual in the prone position, all movements of contents of the large intestine may be regarded as merely translational in, or upon, the same plane, this being an approximately horizontal one. But when the individual stands erect, the segments of the large intestine are at once resolved into two diametric opposites with respect to gravity. The cecum, ascending colon and distal limb of the transverse colon have to propel their contents against a gravitational field, while the proximal limb of the transverse colon and the descending colon have exactly the opposite task. In brief, the dynamics of one group of segments is to lift weight, that of the other group is to lower it.

This difference in dynamics is clearly reflected in the state of filling of the two groups of segments. Thus, the descending colon, where in the upright posture weight is lowered, usually presents itself as a contracted, empty tube. On the other hand, the distal limb of the transverse colon, where weight must be raised from the most dependent part of the loop through a steep ascent to the splenic flexure, is, in any posture, usually filled with gas and semisolid contents. The proximal limb of the transverse colon, a weight-lowering segment, may or may not be filled, depending on the quantity of contents of the whole loop. Finally, the ascending colon and its cul-de-sac, the cecum, are, in most positions, filled to distention, since their work is to raise a column of liquid contents against gravity until such contents pass the brim of the ascending colon at the hepatic flexure.

With the foregoing facts in mind, there is a tendency to view the cecal cul-de-sac as merely a distention due to the column of contents which it supports. However, this view does not take into account the known embryology and comparative anatomy of the cecum, for example as presented by Huntington,[4] Kelly and Hurdon,[5] and Keith.[6] The cecum and appendix are structures in their own right, *i.e.*, their ontogeny is quite distinct and independent of any weight-bearing function. Even so, a suggestive relation between weight-bearing and cecal contour will be discussed below.

Interesting as it would be to consider the comparative anatomy and embryology of the cecum-appendix, attention must be confined to the classic human types (Fig. 2). In type A, the infantile contour, the cecum is a pyramid with the appendix arising from the inverted apex. In type B, found most frequently in early years of childhood, there is a symmetrical growth-distention of right and left sides, with the appendix attached to the most dependent part of the cecum. Type C exemplifies the usual adult form of the cecum, where there has been a differential growth-distention in favor of the right ventral aspect of the cecum, in such degree as to cause the appendix to arise distinctly to the left and dorsally, one to one and one-half inches (2.5 to 3.7 cm.) below the ileocecal valve. Normal variations in cecal contour may be said

to have their distribution on either side of type C, with diversities arising from the degree of growth-distention of the right side, to which latter circumstance is largely due the relative distance of the appendix from the ileocecal valve. With excessive extension of the right wall of the cecum the root of the appendix may lie close to, or even somewhat behind, the ileocecal junction.

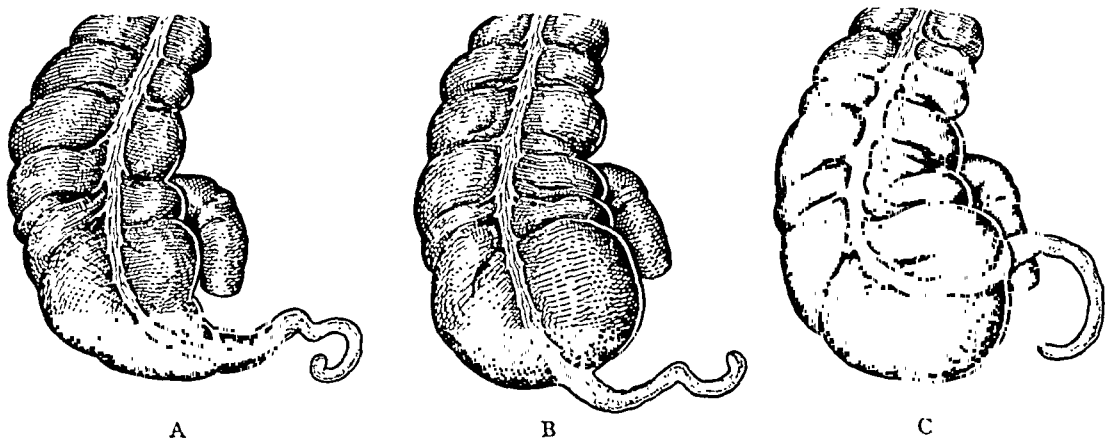


FIG. 2.—(A) The infantile cecum-appendi (B) The cecum-appendix during early years of childhood. (C) The usual adult cecum-appendix, where the appendix arises dorsally and to the left as a result of growth-distention of the right ventral wall of the cecum. All three specimens are viewed from in front.

The three types, A, B and C, offer a suggestive sequence of development in the light of the aforesaid weight-bearing properties of the cecum. Type A, the infantile or nonweight-bearing cecum, is in fact strikingly similar to the adult contracted cecum of Fig. 1 B. During the early years of childhood the first contour of the weight-bearing cecum (Fig. 2, type B) is a fairly symmetrical growth-distention of right and left sides. The adult cecum (type C), representing a long period of weight-bearing, shows a variable, but usually high, degree of growth-distention on the right side.

The term "growth-distention," used in the above discussion, may seem to beg the question. Yet a summary of the evidence and reasoning on this point will indicate the propriety of this term. The cecum and appendix are, as already mentioned, developmental structures in their own right, wholly independent, as far as ontogeny is concerned, of any function of weight-bearing. From a consideration of the digestive tract as a whole, the cecum appears as a midgut expression of that general tendency toward diverticulum formation, which in the foregut gives rise to such important structures as the liver and pancreas. The hypothesis offered here to account for the contour of the cecum is as follows: Given in the newborn a diverticulum, the type A cecum-appendix, with this taking a position in the right iliac fossa at the lower end of the ascending colon, when the child assumes more and more the upright posture, the weight-bearing function becomes increasingly a factor in shaping the contour of the cecum. Also during these early years of childhood the cecum shares in the linear and lateral growth of the gastro-intestinal tract, while the lymphoid tissue of the appendix grows more rapidly than other parts of this organ, which latter as a whole continues as a vestigial structure with progressive reduction of lumen. Accordingly, the type B cecum-

appendix may be regarded as a resultant of weight-bearing and intrinsic growth, the conspicuous manifestation of which is a fairly symmetrical growth-distention of right and left sides of the cecum.

As weight-bearing and growth continue with increasing age of the individual, a differential is set up in favor of the right wall of the cecum, this by reason of the ileocecal junction and by the blood supply of the appendix, both forming a drag or fixation for the left wall. This differential appears to operate largely as the result of weight-bearing, and once set up is readily extended to produce the definitive type C of the adult cecum-appendix. Thus, it is held that the changes of cecal contour from A through B to C are the net results of growth and gravity, or as expressed above, growth-distention. Even where gravity appears to account for the enlargement of the right wall of the cecum, as in the transition from B to C, there is still the possibility that weight-bearing may in itself be something of a growth-promoting agent.

The foregoing hypothesis is well supported by contours of the cecum-appendix in anomalous positions. Thus in cases of undescended cecum the contour is either that of type A or type B (Fig. 2); in other words the usual right-sided growth-distention (producing type C) has not occurred because in these cases the weight-bearing of cecal contents is not a factor in shaping the cecum. On the other hand, where the cecum has descended and in so doing has become inverted, there are varying degrees of right-sided growth-distention, depending both on the length of the inverted segment and on the amount of traction exerted by the ileum and the blood vessels of the cecum-appendix.

Positions of the Appendix.—In view of the fact that the appendix is frequently mobile, it seems that undue attention has been given to its supposed directions. This is not to minimize the importance of two general categories of appendix: (1) The adherent retropostures (behind the colon, cecum or ileum); and (2) the freely mobile, which latter may be postcecal or otherwise directed. The developmental sequence by which one or other of these appendices is produced should here be mentioned briefly.

It will be recalled that at the tenth week of fetal life the midgut loop returns by normally definite sequence through the umbilical orifice to the abdominal cavity (Dott[7]). On completion of this return the cecum first lies free near the umbilicus and ventral to the small intestine and mesenteric artery. However, the colon now begins to straighten and carries the cecum with it upward and to the right, the colon itself lying across the pedicle of the intestinal mass and mesenteric artery, the cecum lodging beneath the liver. Subsequently, by apparent retraction of the liver and by linear growth of the colon, the cecum reaches its final position in the right iliac region. This descent of the colon from liver to iliac region may, and often is, attended in transit by a folding under of the appendix, which latter forms an inclusion behind the colon during peritoneal fixation of this part of the large bowel. On the other hand, if the appendix remains free and directed caudally during the whole descent of the cecum, then, after fixation of the colon, it is left as

a permanent and definitive organ of great mobility, barring of course subsequent pathologic episodes which may render it adherent.

The fixed and mobile categories of appendix are not especially emphasized by Wakeley[8] in his study of 10,000 cadavers. He merely classifies the appendix according to its various directions thus: Retrocolic or postcecal 65 per cent; pelvic 31 per cent; postileal, preileal and subcecal 4 per cent. To most surgeons and anatomists the very high incidence given by Wakeley for retropostures of the appendix will doubtless seem far out of line with their own experience. His incidence of 65 per cent includes all appendices retroposed to cecum and colon, whether adherent or lying free in the retrocecal fossa. To be sure, his series of 10,000 cadavers is much larger than any other known to us at present. Even so, the trend of smaller series is uniformly toward preponderance of the three to six o'clock quadrant of directions rather than toward what may be interpreted as the 9 to 12 o'clock quadrant of Wakeley's series. Thus Kelly and Hurdon give the following directions of the appendix, listed in order of frequency—(1) into pelvis; (2) along iliac vessels; (3) to promontory of sacrum; (4) behind cecum; (5) under ileum; (6) lateral to cecum; (7) into iliac fossa; (8) among coils of small intestines; and (9) mesial to cecum over ileum. The above listing is evidently drawn more or less from data of other reports, concerning which Kelly and Hurdon remark: "The literature on the subject of positions of the appendix is full of the most elaborate statistics, but as they make unprofitable and difficult reading, they have been largely omitted and only the average of the combined results is given." It seems to us, too, that elaborate statistics on this question are unprofitable, not so much as a matter of difficult reading, but because, in so far as they deal with the mobile appendix, they probably have no real significance.

Historical Résumé.—The history of the diseased appendix, like that of circulation of the blood, is an extended chronicle of misinformation, misjudgment and obscurant terminology. Abscesses in the right iliac fossa had long been recognized as frequent and peculiarly fatal. But the only organ in this region capable of producing such disturbance was thought to be the cecum. So, through many decades of dismal controversy, there arose such terms as typhilitis, perityphilitis, paratyphilitis, typhlo-enteritis, and what not, all focusing attention on the cecum as the sole offending part. This being a period when the surgeon-anatomists were making headlong advances in other fields, it must seem to us now tragically odd that autopsy findings of that time were so grossly misinterpreted.

The appendix was, of course, known, but only as an insignificant rudimentary structure, to which no one thought of attributing any special pathology. The prevailing syllogism of that day appears to have been: (1) Only a large organ in the right iliac fossa can produce a large abscess (or grave prognosis). (2) The cecum is the only large organ in the right iliac fossa. (3) Therefore, the cecum produces the large abscess (or grave prognosis). This tacit correlation between the size of the organ and the size of the

abscess or gravity of prognosis did eventually, and reluctantly, give way to a clear recognition of the appendix as the organ involved, the idea finally being crystallized in explicit terminology. The first use in all literature of the word *appendicitis* appears in the following sentence from the classic paper by an American, Reginald Fitz,[9] in 1886: "As a circumscribed peritonitis is simply one event, although usually the most important, in the history of inflammation of the appendix, it seems preferable to use the term appendicitis to express the primary condition." If Fitz did nothing more than give the correct name to a specific pathology, his communication would have been notable; but as a matter of fact his review of the history, his understanding of the condition itself, his statistical treatment and his recommendation of early surgical intervention were, indeed, the stroke of a master.

Another contribution soon to appear was that of Charles McBurney,[10] in 1889, who defined the well-known point bearing his name as follows: ". . . I refer again to the important aid to diagnosis of which I have already spoken, namely, the ascertaining, by the pressure of a single fingertip, that the point of greatest tenderness is, in the average adult, almost exactly two inches from the anterior iliac spine, on a line drawn from this process through the umbilicus. Much greater tenderness at this point than at others, taken in connection with the history of the case and the other well-known signs, I look upon as almost pathognomonic of appendicitis. This point indicates the situation of the base of the appendix, where it arises from the cecum, but does not by any means demonstrate, as one might conclude, that the chief point of disease is there. The abscess, or concretion, or cyst may be at quite a little distance, but the greatest pain, on pressure of one finger, will be felt at the point described."

The diagnostic value of a single point of greatest tenderness in appendicitis is too familiar to require comment. But there were weaknesses in McBurney's pathologic anatomy. In the first place, he defines precisely a surface point, which actually may have a wide range of variation, depending on sex, constitutional type and state of nutrition of the individual. In the second place, he undertakes to make this surface point coincide with a very definite point of underlying visceral topography, namely the junction of appendix and cecum. It is now thoroughly recognized from roentgenologic studies that the topographic point of junction of appendix and cecum is extremely variable. Barclay[11] has an interesting demonstration (his Fig. 86) of a skeletal outline, whereon the sites of the cecal end of the appendix are traced from 30 unselected roentgenograms. In not a single case does this site coincide with McBurney's point; in only seven does it fall within a small circle around the point; in ten it is above the spino-umbilical line, far medial to the point; in 13 it is below the spino-umbilical line, seven of these being medial to the point, six lateral to it. Thus, in only seven out of 30 cases does the junction of appendix and cecum fall any way near McBurney's point. The distribution of these sites in the Barclay illustration prove, as

well as anything could, the futility of a rigid, preroentgenologic concept of surface topography, as applied to the mobile viscera.

Again, as for McBurney's point, the confusion arising from variability is further confounded by compilers of anatomic text-books setting up definitions of their own invention, though still, for some reason, retaining the name McBurney to identify the point defined. Where students, such as ours, use a number of different texts, and find among them at least three diverse specifications for McBurney's point, one can well assert that the resulting confusion is complete. If eponyms must be used—and there seems no present way of eradicating them—then, in plain deference to historic accuracy, they should be used in their original meaning. While the name McBurney, associated with a single point of greatest tenderness in appendicitis, is doubtless of value in emphasizing the existence of such a point, whose diagnostic worth no one disputes, it is our contention here that to give precise topographic definition to such a point is beyond the possibilities of sound human anatomy.

SUMMARY

The appendix is frequently one of the mobile viscera of the abdomen. Its position at any given time depends largely on the cecum, which latter varies in contour and even in position, as a result not only of type but also of peristaltic activity, state of filling and other physiologic conditions. Three general types of ceca, (1) the infantile; (2) that prevailing in early childhood; and (3) the adult, may be regarded as a developmental sequence. The factors of intrinsic growth and of gravity (weight-bearing of cecal contents) are considered in the evolution of the cecum from infantile to adult types. The directions taken by the appendix are not regarded as significant, when the appendix itself is mobile. From this it follows that but two general categories of appendix are proposed, the fixed and the mobile. Two historic events are recounted in connection with the diseased appendix, *viz.*, the first use of the word appendicitis, proposed by Fitz, in 1886; the designation of the point of greatest tenderness in appendicitis by McBurney, in 1889. The futility of defining McBurney's point is recognized, especially in reference to the highly variable topography of the junction between appendix and cecum.

REFERENCES

[1] Maingot, R.: Postgraduate Surgery. Vol. 1. D. Appleton-Century Co., 1938.

[2] Cannon, W. B.: The Movements of the Intestines Studied by Means of the Roentgen Rays. Am. Jour. Physiol., 6, 251, January, 1902.

[3] Hurst, A. F.: Constipation and Allied Intestinal Disorders. Oxford Medical Publications, 1909.

[4] Huntington, G. S.: Anatomy of the Human Peritoneum and Abdominal Cavity Considered from the Standpoint of Development and Comparative Anatomy. Lea & Febiger, 1903.

[5] Kelly, H. A., and Hurdon, E.: The Vermiform Appendix and Its Diseases. W. B. Saunders & Co., 1905.

[6] Keith, A.: Human Embryology and Morphology. 5th edit., Wm. Wood & Co., 1933.
[7] Dott, N. M.: Anomalies of Intestinal Rotation; Their Embryology and Surgical Aspects; with Report of Five Cases. Brit. Jour. Surg., 11, 251, October, 1923.
[8] Wakeley, C. P. G.: The Position of the Vermiform Appendix as Ascertained by Analysis of 10,000 Cases. Jour. Anat., 67, 277, January, 1933.
[9] Fitz, R. H.: Perforating Inflammation of the Vermiform Appendix; with Special Reference to Its Early Diagnosis and Treatment. Am. Jour. Med. Sci., 92, 321, October, 1886.
[10] McBurney, C.: Experience with Early Operative Interference in Cases of Disease of the Vermiform Appendix. New York Med. Jour., 50, 676, July-December, 1889.
[11] Barclay, A. E.: The Digestive Tract, A Radiological Study of Its Anatomy, Physiology and Pathology. 2nd edit., Cambridge Univ. Press, 1936.

BENIGN TUMORS OF THE OVARY ASSOCIATED WITH ASCITES AND PLEURAL EFFUSION*

REPORT OF A CASE OF MULTILOCULAR CYSTADENOMA

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WITHIN recent years an increasing number of benign tumors of the ovary associated with ascites and pleural effusion have been reported. The tumor in each instance has been an unilateral or bilateral fibroma.

It is obvious that the total number of such cases cannot be very large because fibroma itself as Peterson[1] and Kelly[2] have observed, is one of the rare ovarian tumors. Nevertheless a considerable number of fibromata have been recorded. Doran[3] reported 11 cases in 1896, Dartigues,[4] in 1899, included 20 cases of fibroma in a monograph on solid tumors of the ovary, and Peterson,[1] in 1902, described two cases of his own, to which he added 82 cases from the literature. In 1923, Hoon[5] reported 55 cases from the Mayo Clinic.

An associated ascites has been a frequent but not a constant finding. It was present in five, or 45 per cent, of the 11 cases reported by Doran[3]; in 34, or 40 per cent, of the 84 cases reviewed by Peterson[1]; and in 14, or 25 per cent, of the 55 cases reported by Hoon.[5]

Pleural effusion as well as ascites is sometimes found but much less frequently than ascites alone. In 1879, Cullingworth,[6] of Manchester, described what appears to have been an authentic case. The patient, a widow, age 36, was admitted to St. Mary's Hospital, Manchester, England, March 11, 1879, because of slight uterine hemorrhages of three months' duration. At that time, she was described as having a florid complexion and as being apparently in good health. The hemorrhages ceased about the middle of June, 1879, from which time the patient's health rapidly declined. She lost flesh and ascites supervened. She suffered also from pleurisy, first on the left side, where an effusion took place, and subsequently on the right side, where loud friction sounds were audible to within a short time of her death. On September 10, 1879, she became suddenly worse, with symptoms of intense dyspnea and general collapse, and died the following day.

At autopsy, the left pleural cavity was found full of fluid, and the whole of the left lung was entirely collapsed. On the right side, the lower lobe was firmly attached by recently formed adhesions to the diaphragm and chest wall, and the whole lung was congested and edematous. There was a large quantity of fluid in the peritoneal cavity and the peritoneum was thickened and opaque. Large, bilateral, solid tumors of the ovaries were found. After microscopic examination, Doctor Dreschfeld, of Owens College, made a diagnosis of ovarian fibromata.

* Read before the Pan-Pacific Surgical Association, Honolulu, T. H., September 20, 1939. Submitted for publication November 20, 1939.

In the discussion which followed Mr. Cullingworth's presentation, Mr. Lawson Tait observed that the ascites and pleural effusion seemed to him to be of very great importance in both the clinical and pathologic aspects of the case. He stated that he had observed a number of cases of ovarian tumors complicated with cancer, and in several the rapid effusion of pleural fluid had been the cause of death. Because of this fact he was not disposed to accept Mr. Cullingworth's specimen as necessarily one of a nonmalignant character. Doctor Wiltshire also thought that the pleural effusion was strongly suggestive of malignancy, unless there was some other cause for it, for example, acute pleurisy.

In reply, Mr. Cullingworth said that the possibility of cancerous origin of the effusion into the pleural and peritoneal cavities had been considered at the autopsy, but that very careful and minute inspection failed to discover more than a thickened and opaque condition of the pleura and peritoneum.

For a further report, the specimen was referred to a subcommittee, consisting of Mr. Alban Doran and Mr. Knowsley Thornton who thought the term mixed sarcoma would most correctly describe both tumors. In presenting their report, however, they stated that the tumors, owing to postmortem changes and to the action of alcohol, were not in a satisfactory condition for accurate examination of their more delicate cell structures.

In spite of the report of this subcommittee, one is impressed by Mr. Cullingworth's observations, and in the light of our present knowledge it appears probable that this case was one of benign ovarian fibromata associated with peritoneal and pleural effusion. It is also likely that this is one of the first, if not the first, to appear in the modern literature.

Pleural effusion was observed in one of the cases reported by Doran,[3] and Dartigues[4] listed it among the complications of ovarian fibroma. Owen,[7] in 1923, stated that it might occur, but he was not able to detect it in the case he reported. Two of the 55 cases reported by Hoon[5] had bilateral hydrothorax as well as ascites. A single case of ovarian tumor with ascites and pleural effusion was reported in detail by Leo[8] in 1926. His description, however, does not reveal the identity of the tumor. Salmon,[9] in 1934, described two cases of ascites and pleural effusion coexisting, in one case with an ovarian fibroma, and in the other with a fibroid tumor of the uterus. In his book on "Tumors of the Female Pelvic Organs," published in 1934, Meigs[10] described three such cases from the Massachusetts General Hospital, and, in 1937, he and Cass[11] reported these with an additional case from the Massachusetts General, and three cases from the literature, making a total of seven cases. They called attention to the possible existence of hydrothorax as well as ascites in cases of benign fibroma and emphasized the importance of recognizing this possible association.

In discussing the presentation of Meigs and Cass,[11] Dr. W. T. Dannreuther, of New York, reported the removal of a tumor which had the gross appearance of an adenocarcinoma but which proved to be benign and which was associated with fluid in the abdomen and right chest. According to

more recent information[12] this patient remained well for two years and then again developed ascites which progressed rapidly. Abdominal exploration revealed inoperable carcinoma from which the patient died within a month. During her last illness, however, there was no evidence of a pleural effusion. Continuing the discussion of the work of Meigs and Cass,[11] Dr. T. E. Jones,[17] of Cleveland, and Dr. W. T. Black,[16] of Memphis, each reported a case of ovarian fibroma with ascites and hydrothorax. Jones's case had been previously operated upon for carcinoma of the breast and was thought to have abdominal metastasis. She was cured by aspiration of the chest fluid and removal of the ovarian tumor. The true condition in Black's[16] case was discovered at autopsy. Rhoads and Terrell[13] described a single case in 1937, and, in 1938, Weld[14] reported two cases. In his last article on the subject Meigs[15] reviewed a total of 15 cases, including the original seven.

The case which is herewith reported in connection with the present discussion—a multilocular cystadenoma—appears to constitute an exception to the type of ovarian tumor which has ordinarily been associated with ascites and pleural effusion.

Case Report.—Hosp. No. A6439: E. B., white, female, age 54, was admitted to St. Luke's Hospital, November 23, 1938. Her chief complaints were swelling of the abdomen, shortness of breath, loss of appetite, weight, and strength.

For about one year the patient had observed a steady increase in the size of her abdomen. It had gradually become so large and heavy that she could no longer pursue her usual activities. At the same time there was a loss of flesh from other parts of her body. During the few weeks preceding her admission to the hospital she became very dyspneic and experienced, almost constantly, a distressing sense of suffocation. It had been necessary for her to remain in bed most of the time with the head and thorax elevated. There had been no pain in the abdomen or chest and only a slight dry cough, but her nights were disturbed by profuse sweating.

The past history was irrelevant. There had been two abortions, each at three months, and no children. The menopause had occurred three years previously without untoward incident. One year before admission there had been some vaginal bleeding which persisted three weeks and then subsided spontaneously.

Physical Examination.—The patient was generally emaciated. Excursions of the right chest were limited and the physical signs indicated the presence of fluid over almost the whole of the right lung field. The abdomen showed great enlargement, and exhibited a fluid wave and the usual signs of ascites. A large tumor could be felt extending from below the level of the pubis to the upper abdomen where it disappeared under the costal margins. A slight irregularity of its surface could be felt in the left subcostal region. On pelvic examination, the cervix was found to be displaced anteriorly by a tense mass which projected downward behind the uterus.

A roentgenogram (Fig. 1) showed density throughout the right chest suggesting a right pleuritic effusion. The blood count was: R.B.C. 4,850,000, hemoglobin 96, W.B.C. 10,200, polymorphonuclear leukocytes 87, lymphocytes 9, large mononuclear and transitional cells 4.

The right chest was aspirated, and 1,500 cc. of dark, yellowish-green fluid were removed. The fluid contained desquamated pleural cells and a few lymphocytes. No tumor cells were found in the centrifuged specimen, and no tubercle bacilli could be demonstrated. A guinea-pig, inoculated with the fluid, showed no sign of tuberculosis after six weeks.

In view of the markedly distended abdomen, the pleural effusion, the loss of appetite,

weight, and strength, a tentative diagnosis of ovarian carcinoma with peritoneal and pleural metastasis was made. Operation was decided upon in the hope that removal of the large tumor might alleviate the condition to some extent and enable the patient to enjoy, for a time at least, a greater degree of activity.

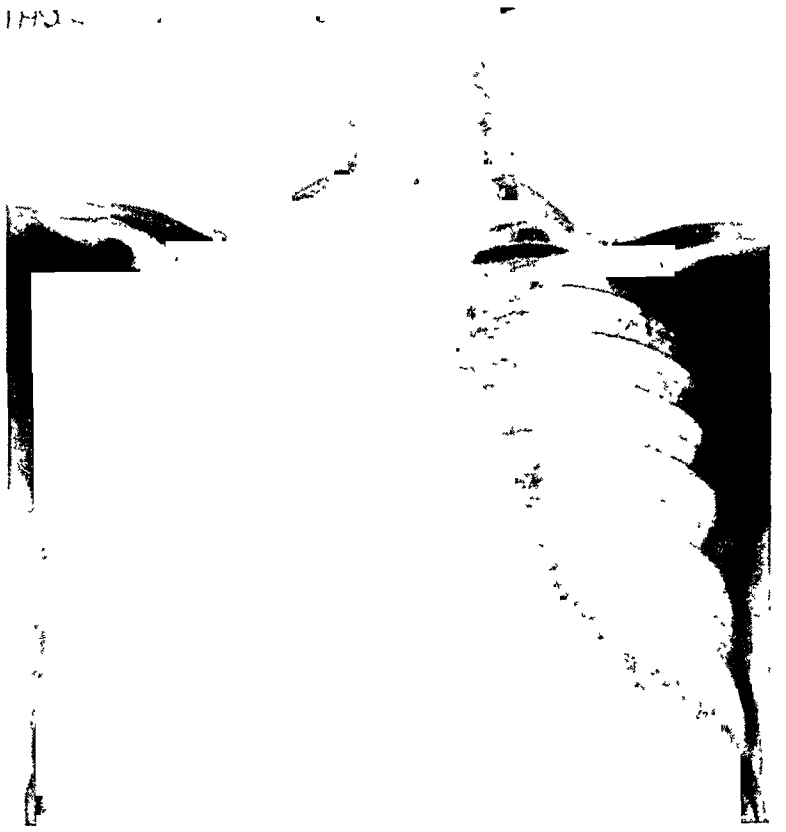


FIG. 1.—Roentgenogram of the chest upon admission showing right chest filled with fluid.

Operation.—December 1, 1938: A tumor which filled the entire abdomen was removed (Fig. 2). It arose from the left ovary and was attached by a rather thin pedicle. There was a relatively small amount of free, amber-colored fluid in the abdomen, but no peritoneal implants or other definite evidence of malignancy. The right ovary appeared to be essentially normal, but it was removed because the process in the left ovary was considered to be probably malignant.

Pathologic Examination.—Gross: "The specimen consists of a large left ovarian cyst and tube. The cyst measures 27 x 30 x 14 cm. and weighs 17 lbs. It is covered with a smooth, tough, membranous gray wall. There are several irregularities of the surface. The left tube measures 11 cm. long and 0.7 cm. in diameter and is attached to the cyst. It appears normal. On section, the cyst is made up of many smaller cysts containing fluid of varying consistency; some are filled with material of sebaceous character, some with thick greenish fluid, and some with clear thin fluid. There are numerous cellular nodules throughout.

"The right ovary and tube, closely bound together by adhesions, are also present. The tube is sealed but only slightly distended. The serosa is rough.

"The piece of omentum measures 12 x 6 x 0.5 cm. and is slightly roughened, but shows mostly orange fat in a thin web of peritoneum and no gross tumor. The ovary is small and shows one small cystic follicle."

"Microscopic.—Sections through the wall of the left ovarian cyst show that there is a dense fibrous capsule within which there are masses of adenomatous tissue, with the formation of some discrete glands and without much mucous content. In others, there is hypersecretion but the cells are not of the tall columnar type such as is found in multilocular pseudomucinous cysts. The tumor is apparently a less differentiated one, although closely related. All of the cells appear to be limited by the basement membrane, and there is no evidence of invasion through the wall or of a primary malignant process (Figs. 3 and 4)."

The right ovary contains a small epithelial-lined cyst which may have the same origin as the large one. There are also calcified areas throughout the ovary; these also, in some instances, being lined with a layer of columnar cells. These cysts have probably both arisen from congenital remnants which are numerous in both ovaries, but the process appears to be benign in each. The tube shows some dilatation and chronic inflammation. *Pathologic Diagnosis:* Multilocular cystadenoma of left ovary. Epithelial ovarian cysts, right ovary. Chronic salpingitis.

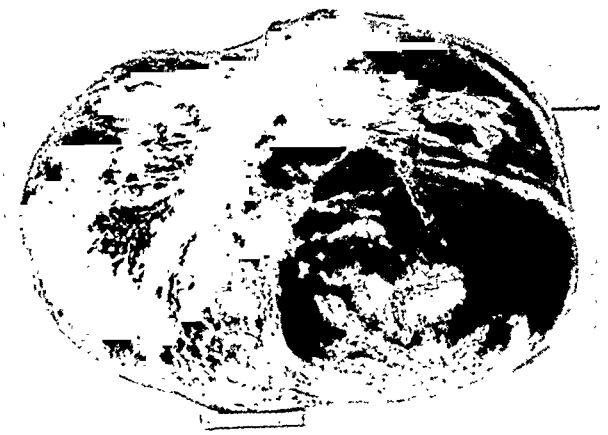


FIG. 2.—Photograph of the cystadenoma removed at operation. Weight 17 pounds (approximately 8 Kg.). Scale in centimeters.

Subsequent Course.—On the tenth postoperative day 1,500 cc. of additional fluid were removed from the right chest; a roentgenogram taken after the removal showed



FIG. 3.—Photomicrograph showing multilocular character of tumor. (Low power)



FIG. 4.—Photomicrograph showing the limitation of the lining epithelial cells by basement membrane and the benign character of the histologic structure. (High power)

no evidence of tuberculosis or other pulmonary disease (Fig. 5). There was no further accumulation of fluid, and convalescence was uncomplicated with the exception of the night sweats which persisted for about three weeks and then ceased. The patient gradually regained her appetite, weight, and strength, and was entirely well when last heard from, November 2, 1939, 11 months after operation.

In the case herewith reported the tumor was a multilocular cystadenoma, but, in all other essential respects, it was similar to the cases of fibroma which have been previously reported, and fits into the symptom complex described

by Meigs and Cass.[11] The predominating symptoms were related to interference with proper aeration, and the physical findings were similar to those observed in cases of ovarian fibroma with ascites and pleural effusion. Ablation of the tumor and removal of the pleural fluid likewise terminated the disease.

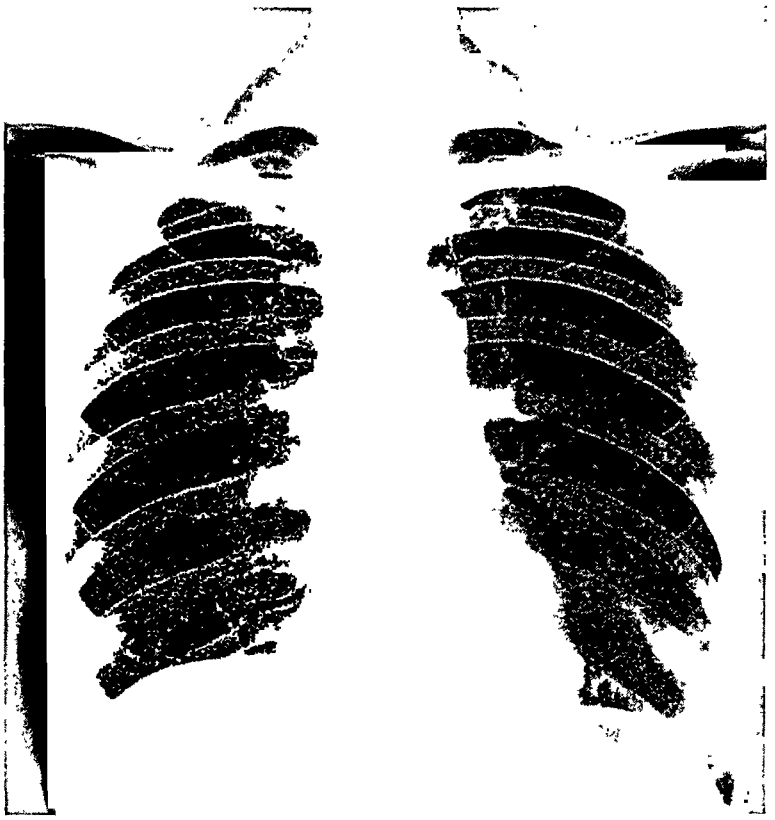


FIG. 5.—Roentgenogram at the time of the patient's discharge from hospital, 23 days after operation, showing chest clear.

The amount of fluid in the chest and the rapidity of its reaccumulation has varied considerably, and no satisfactory explanation of its occurrence has been offered. In the case described by Rhoads and Terrell[13] the effusion was massive and thoracenteses were performed five times within a month; fluid in amounts ranging from 1,000 to 3,000 cc. was removed each time. Leo's[8] patient also required the removal of large amounts of pleural fluid at frequent intervals. In the case just described there were two aspirations of the chest, one a week before operation and the other ten days postoperative. An associated ascites has been found in all the cases which have had pleural effusion, and cachexia has been frequent. Removal of the ovarian tumor and aspiration of the chest fluid has been sufficient to effect a cure in all patients who have been operated upon. Three patients, one reported by Cullingworth,[6] one by Doran,[3] and one by Black,[16] died without operation, the true condition being discovered at autopsy.

CONCLUSIONS

It appears sufficient to call attention, as Meigs and Cass[11] have done: First, to the possible coexistence of ascites and pleural effusion in association with a benign tumor of the ovary; and second, to the possibility of effecting a cure by simple removal of the tumor.

REFERENCES

[1] Peterson, R.: A Consideration of Ovarian Fibromata Based on a Study of Two Recent Cases and 82 Collected from the Literature. Am. Gynec., 1, 45–68, 1902.

[2] Kelly, H. A.: Gynecology. New York, D. Appleton-Century Co., Inc., 1928.

[3] Doran, A.: Cases of Fibroma of the Ovary and Ovarian Ligament Removed by Operation; with a Series of After-Histories of Cases Reported in the "Transactions" since 1879. Transactions of London Obstetrical Society, 38, 187–212, 1896.

[4] Dartigues, L.: Étude étioligique et anatomo-pathologique des tumeurs solides de l'ovaire. Rev. de gynéc. et de chir., 3, 601–644, 1899.

Ibid.: Symptomatologie des tumeurs solides de l'ovaire. Pp. 793–848.

Ibid.: Diagnostic et traitement des tumeurs solides de l'ovaire. Pp. 1013–1036.

[5] Hoon, M. R.: Fibromata of Ovary. Surg., Gynec., and Obstet., 36, 247–251, 1923.

[6] Cullingworth, C. N.: Fibroma of Both Ovaries. Transactions of the Obstetrical Society of London, 21, 276–288, 1879.

[7] Owen, A. W.: Fibroma of Ovary; with an Account of a Case. Lancet, 1, 1211–1212, 1923.

[8] Leo, C.: Processo essudative pleuro-peritoneale ribelle guarito in seguito a laparatomia per tumore ovarico. La Med. Prat., 11, 422–426, November 30, 1926.

[9] Salmon, U. J.: Benign Pelvic Tumors Associated with Ascites and Pleural Effusion. Jour. of Mt. Sinai Hosp., 1, 169–172, November and December, 1934.

[10] Meigs, J. V.: Tumors of the Female Pelvic Organs. New York, The Macmillan Co., 1934.

[11] Meigs, J. V., and Cass, J. W.: Fibroma of the Ovary with Ascites and Hydrothorax; with a Report of Seven Cases. Am. Jour. Obstet. and Gynec., 33, 249–267, 1937.

[12] Dannreuther, W. T.: Personal communication.

[13] Rhoads, J. E., and Terrell, A. W.: Ovarian Fibroma with Ascites and Hydrothorax (Meig's Syndrome). J.A.M.A., 109, 1684–1687, November 20, 1937.

[14] Weld, S. B.: Fibroma of the Ovary with Ascites and Pleural Effusion. New England Jour. Med., 218, 262–265, February, 1938.

[15] Meigs, J. V.: Fibroma of the Ovary with Ascites and Hydrothorax. A Further Report. ANNALS OF SURGERY, 110, 731–754, October, 1939.

[16] Black, W. T.: Discussion of Meigs and Cass.[11]

[17] Jones, T. E.: Discussion of Meigs and Cass.[11]

STUDIES ON THE CEREBROSPINAL FLUID PRESSURE IN UNANESTHETIZED DOGS

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I. PHYSIOLOGIC RESPONSES TO THE ADMINISTRATION OF INTRAVENOUS FLUIDS IN NORMAL ANIMALS

THE PRACTICE of dehydrating patients with cerebral trauma indicates that there are those[9] who believe that even a normal fluid intake is harmful under these circumstances. The administration of isotonic fluids is supposed to increase the cerebospinal fluid pressure.[9] Clinical observations which we[12] reported previously, however, demonstrated that large quantities of isotonic fluids could be administered to patients with cerebral trauma without significantly increasing the cerebrospinal fluid pressure. The present experiments were undertaken upon normal dogs preliminary to experiments upon dogs with cranial injuries, in order to obtain further information on the effect of isotonic and hypertonic solutions upon the cerebrospinal fluid pressure. Since the observations on patients with cerebral trauma were performed under local anesthesia, similar conditions were used in the experiments reported in this paper.

Method and Procedure.—Mongrel female dogs, weighing approximately 10 Kg., were used in these studies. The animals were fed a mixed diet and given 500 cc. of milk 12 hours before beginning the experiment. After a three-inch bandage was bound over the untrained dog's eyes, the animal remained immobile for hours as it lay on its right side. The willingness to remain quiet and to tolerate the intravenous injection, and maintenance of a needle in the cisterna magna we attributed to the blindfolding. The animal was catheterized. Under local anesthesia, with aseptic precautions, a No. 22-gauge lumbar puncture needle, one and one-quarter inches long, was inserted into the cisterna magna. To the needle, a short segment of rubber tubing and a one Mm. bore manometer were attached. Six-tenths cc. of fluid was required to fill the system to the 50 Mm. mark on the manometer. Throughout the experimental period, the pressure was recorded every ten minutes, and during the injection period five-minute readings were made. An irregular rise or fall in pressure was not recorded unless the change persisted for more than one minute.

In the first group of control experiments, physiologic saline solution was

Submitted for publication August 16, 1940.

used in the manometers. The solution was prepared from compressed tablets of sodium chloride dissolved in single-distilled water. Cell counts were made upon specimens of the cerebrospinal fluid taken at the beginning and end of each experiment, using the technic of Merritt and Fremont-Smith.[19] A gradual rise in the cerebrospinal fluid pressure with pleocytosis was observed in most instances. When a marked pleocytosis was observed, there was a gradual rise in the cerebrospinal fluid pressure in every instance.

Influence of Fluid Used in Manometer Upon Cerebrospinal Fluid Pressure and Pleocytosis.

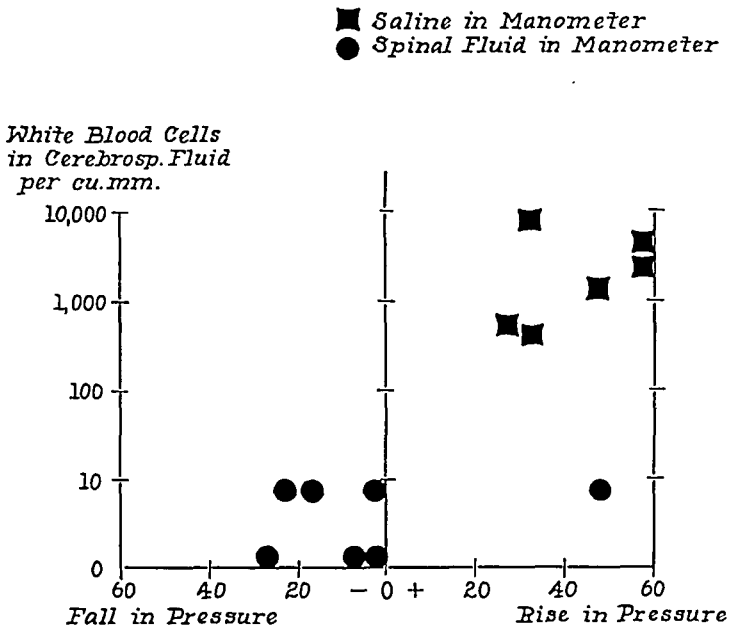


Chart 1.

When the experiment was repeated with the needle alone in the cisterna magna, pleocytosis was not observed. When 0.6 cc. of spinal fluid was used in the manometer in place of the saline solution, the rise in cerebrospinal fluid pressure and pleocytosis were no longer encountered, except in the one instance where a rise in pressure occurred without pleocytosis. Chart 1 illustrates the influence of the fluid used in the manometer upon the cerebrospinal fluid pressure and the presence of white blood cells in this fluid.

In the later experiments, cerebrospinal fluid either from the experimental animal or from another dog was used in the manometer. Experiments were discarded if the spinal fluid contained more than 50 white blood cells per cubic millimeter at the conclusion of the experiment.

Intervals of seven days generally separated experiments upon the same animal. A period of one hour was allowed to establish a control level of pressure. Solutions were then injected intravenously after warming to body temperature. Isotonic fluids were administered during one hour in quantities of 40 to 60 cc. per Kg. Hypertonic solutions were administered, according to the technic of Bullock, Gregersen and Kinney,[3] in quantities of 3.1 Gm. per Kg. of glucose and 6 Gm. per Kg. of sucrose in 50 per cent solutions.

Results.—The cerebrospinal fluid pressure in unanesthetized dogs varied between 75 and 165 Mm. of spinal fluid, as shown in Chart 2. Eighty-one per cent of the determinations fell between 100 and 145 Mm. pressure. The mean pressure was 123 Mm.

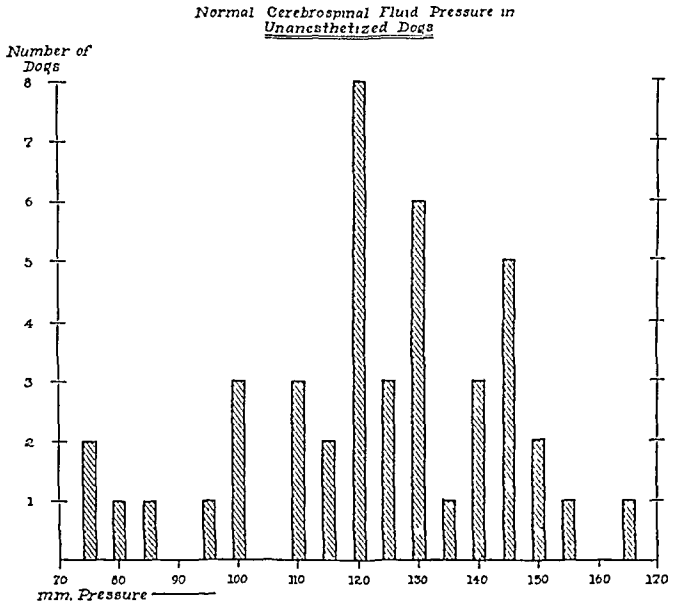


CHART 2.

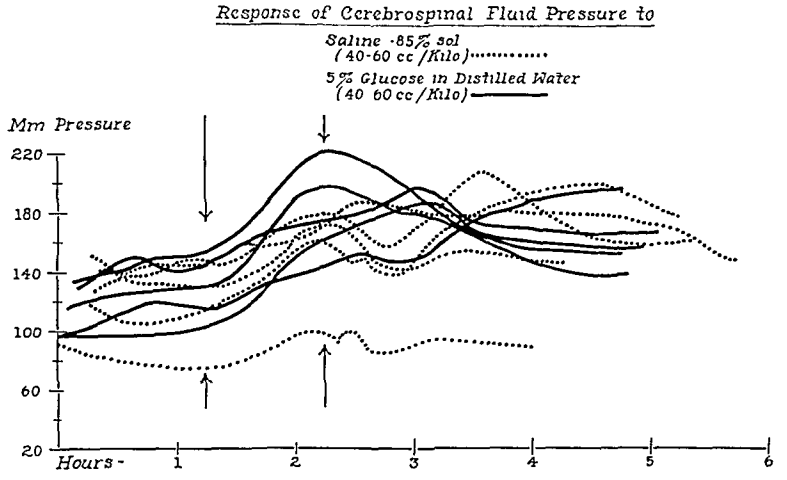


CHART 3.

When isotonic fluids were injected intravenously in quantities of from 40 to 60 cc. per Kg. during a period of one hour, there was an increase in the cerebrospinal fluid pressure as illustrated in Chart 3.

Animals receiving 5 per cent glucose in water excreted 29.1 cc. of urine per Kg., while those receiving the physiologic saline solution excreted 16.1 cc. during the experimental period.

The intravenous administration of 50 per cent solutions of glucose and sucrose produced a fall in the cerebrospinal fluid pressure followed by return to the initial level. No "secondary rise" above the initial level was observed, except in one experiment in which a sucrose solution was used. Chart 4 shows the cerebrospinal fluid pressure changes.

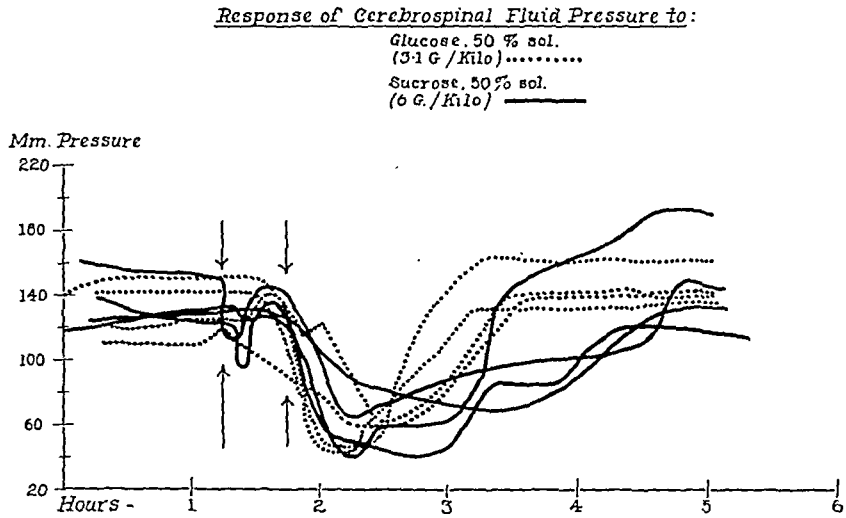


CHART 4.

The diuresis resulting from the injection of the hypertonic sucrose solution averaged 41.2 cc. of urine per Kg., while that for the glucose was 23.7 cc. per Kg. over the period of the experiments.

Discussion.—Hypertonic solutions of glucose and sucrose when injected intravenously caused a temporary fall in the cerebrospinal fluid pressure. A secondary rise above the normal level was observed in only one instance when sucrose was used. These data, therefore, are not in agreement with those of Milles and Hurwitz,[20] who found a "secondary rise" in pressure after the fall produced by the injection of hypertonic glucose solutions. The "secondary rise," they pointed out, was observed only when experiments were prolonged beyond the experimental periods set by other investigators who had not observed the rise. Masserman[17] demonstrated a similar "secondary rise" in observations upon normal humans. Bullock, Gregersen and Kinney[3] suggested using a hypertonic sucrose solution instead of hypertonic glucose, since an undesirable "secondary rise" in pressure occurred only with the latter.

These observers used manometers filled with saline solution to measure the cerebrospinal fluid pressures. Masserman,[16] and Bullock, Gregersen and Kinney[3] encountered not only a "secondary rise" in pressure after the administration of glucose, but also a gradual rise in pressure in control experiments. They did not explain the latter. They demonstrated the presence of large numbers of white blood cells in specimens of cerebrospinal fluid taken at the conclusion of the control experiments and those where glucose and sucrose were used.

In our early control experiments, when saline was used in the manometer, a gradual rise in the cerebrospinal fluid pressure was similarly observed. This variation was attended by the presence of white blood cells in the fluid. We, therefore, used a manometer filled with spinal fluid. With few exceptions, neither a rise in the cerebrospinal fluid pressure nor a pleocytosis was observed. It is possible that the rise in pressure in control experiments and the "secondary rise" following the administration of hypertonic glucose solution, reported by others, is due to the use of saline solution in their manometers. Just what substance in such solutions is responsible for the rise we cannot state at this time.

CONCLUSIONS

(1) The mean cerebrospinal fluid pressure in 43 experiments upon unanesthetized dogs was found to be 123 Mm. of spinal fluid.

(2) When a manometer filled with saline solution was used in unanesthetized, untraumatized dogs, a gradual rise in pressure and pleocytosis was observed. When a manometer filled with spinal fluid was used, with few exceptions, neither a rise in pressure nor pleocytosis occurred.

(3) The intravenous administration of isotonic fluids produced a moderate increase in cerebrospinal fluid pressure over a five-hour period of observation.

(4) Hypertonic solutions of glucose and sucrose, injected intravenously, produced a temporary fall in the cerebrospinal fluid pressure. There was with a single exception no "secondary rise" above the normal level within the experimental period when cerebrospinal fluid was used in the recording system.

II. PHYSIOLOGIC RESPONSE TO THE ADMINISTRATION OF INTRAVENOUS FLUIDS IN DOGS WITH HEAD INJURIES

It has been claimed that increased intracranial pressure is a significant factor in the mortality associated with cerebral injuries.[9, 21] Dehydration of the central nervous system to control the increase in pressure has been proposed as a therapeutic procedure. Fay[9] has presented mortality statistics to support his plan of "dehydration therapy" in cases of cranial injury. Results obtained with this form of treatment, according to Lehman and Parker,[15] were not better than those obtained by others using more conservative methods of treatment. The existence of conflicting views regarding therapy in patients with cerebral injury suggested the need for more information concerning the effect on the cerebrospinal fluid pressure of administering intravenous fluids.

We have studied the effect of the intravenous injection of isotonic and hypertonic solutions and the effect of hydration and dehydration upon the cerebrospinal fluid pressure of the dog with and without cerebral injury. In the course of these studies, certain observations of other phenomena were made. The response of the cerebrospinal fluid pressure to cranial injury was determined; findings relating to recovery or death of the animals were recorded

and correlated; the effect of blood as particulate matter in the cerebrospinal fluid was noted. Since the studies of the cerebrospinal fluid pressure in humans have been made without the use of anesthesia, similar conditions were established in our animals.

Method and Procedure.—Mongrel female dogs, weighing approximately 10 Kg., were used for the experiments. The animals were blindfolded and placed upon the right side for about one hour prior to operative exposure of the left side of the skull. Ether was administered by means of a respirator. The left masseter muscle was reflected from the skull under sterile precautions. The exposed surface was struck four to six blows by means of a steel hammer weighing one and one-half pounds. There occurred a loss of eye reflexes following the trauma, except in two instances. Spontaneous respiration ceased in most cases so that artificial respiration was necessary. The wound was then closed and the anesthesia stopped. Artificial respiration was continued until natural breathing occurred. The animal was again blindfolded, prepared for a cisternal puncture, and catheterized.

With aseptic precautions, a No. 22-gauge needle, one and one-quarter inches in length, was inserted into the cisterna magna after infiltration of the soft tissue with a 1 per cent procaine solution. A specimen of spinal fluid was removed for a count of the red and white blood cells. A manometer of one Mm. bore was attached to the needle in the cisterna and the animal's own fluid allowed to fill the manometer. Six-tenths cc. of fluid was required to fill the system. One hour was allowed for establishing a control level of pressure before the administration of intravenous fluids was begun.

Solutions of 50 per cent glucose in distilled water, 5 per cent glucose in distilled water, and physiologic saline were injected intravenously in quantities of 12 and 40 cc. per Kg. for the hypertonic and isotonic solutions, respectively. Recordings of the cerebrospinal fluid pressure were made every five minutes during the injection period and every ten minutes thereafter. Studies were made on the day of trauma and on subsequent days up to seven days after injury, depending upon the length of survival of each dog. Data recorded included the status of the animal; the cerebrospinal fluid pressure; the character of the cerebrospinal fluid; the response to the intravenous injection of fluids and the quantity of total fluid intake.

Most of the animals which survived the trauma were killed with intravenous sodium amytal one to two weeks following injury. Autopsies were performed on all the animals. Photographs were made of the intact brain and of gross changes present in coronal sections. Specimens were taken for microscopic examination.

Results.—Fracture of the skull was produced in 30 dogs. Blood was present in the cerebrospinal fluid in 23 of these animals. Loss of eye reflexes occurred immediately after trauma in 28. Neurologic disturbances as a result of the trauma were observed in 24. Ten of the dogs died, a mortality of 33 per cent. Table I is a summary of the results of the trauma.

TABLE I

SUMMARY OF THE RESULTS OF TRAUMA

Fractured skull	30
Recovered	20
Died	10
Per cent mortality	33
Loss of eye reflexes	28
Blood in cerebrospinal fluid	23
Residual neurologic disturbances	24

A fairly uniform type of fracture of the skull was produced. The fracture was stellate in character, the line of fracture frequently extending laterally toward the base; there was usually slight depression of the bone underlying the point of impact. In five instances unusual depression of a fragment of bone produced a laceration of the cortex. Gross evidence of injury to the

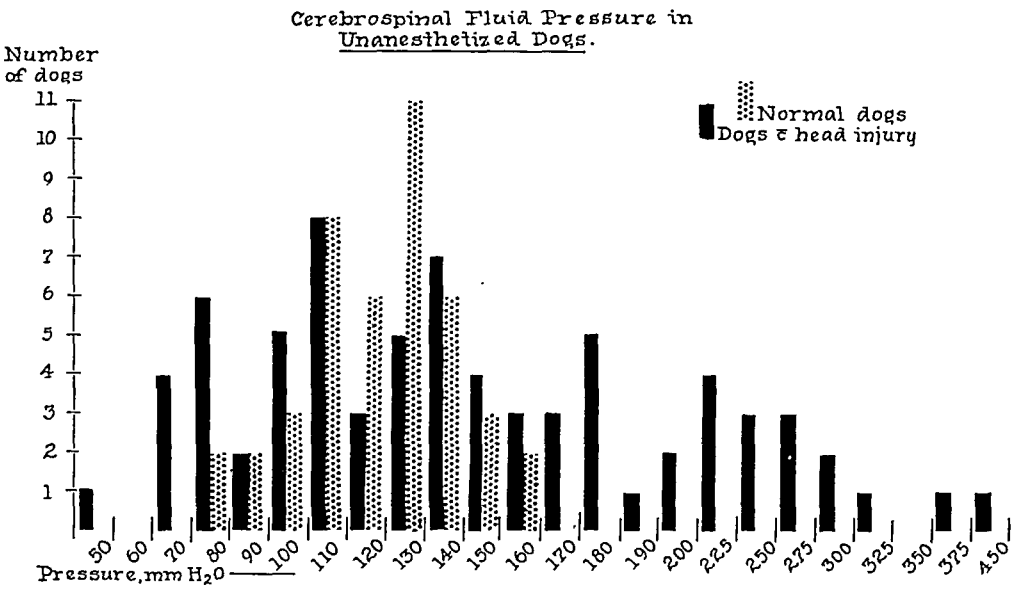


CHART 5.

brain was present in all the animals. The outstanding findings in the brains of the animals that died were subarachnoid and subpial hemorrhages involving the base and brain stem, and punctate hemorrhages in the medulla. Animals that survived showed less severe submeningeal hemorrhage and fine petechial hemorrhages both in and distant from the area of trauma. PLATES I and II indicate the extent of the gross injury which was characteristic of the group of animals that survived in comparison with those that died.

The cerebrospinal fluid pressure of the dogs with head injuries is shown in Chart 5. The recorded pressures were determined in nearly every instance after a one-hour period of observation. In the same chart, pressures previously observed in 43 normal dogs are indicated for comparison. Twenty-eight determinations were made on the day of injury, before the injection of various types of fluid, 19 on the first day after trauma, and 26 at intervals from the second to the seventh day.

The cerebrospinal fluid pressure was less than 200 Mm. of water in 80 per cent of the determinations. In 12 instances, the pressure was between 200 and 300 Mm.; in three, it was above 300 Mm., the highest pressure recorded being 450 Mm. Two deaths occurred in animals which had pressures below 200 Mm. Six deaths occurred among animals having pressures which were above 200 Mm. In the latter instances, severe, diffuse hemorrhage was observed at autopsy. In two instances the animals died immediately after trauma, before the cerebrospinal fluid pressure was recorded.

When isotonic fluids in quantities of 40 cc. per Kg. (corresponding to 3,000 cc. of fluid for a human), were injected intravenously during a period

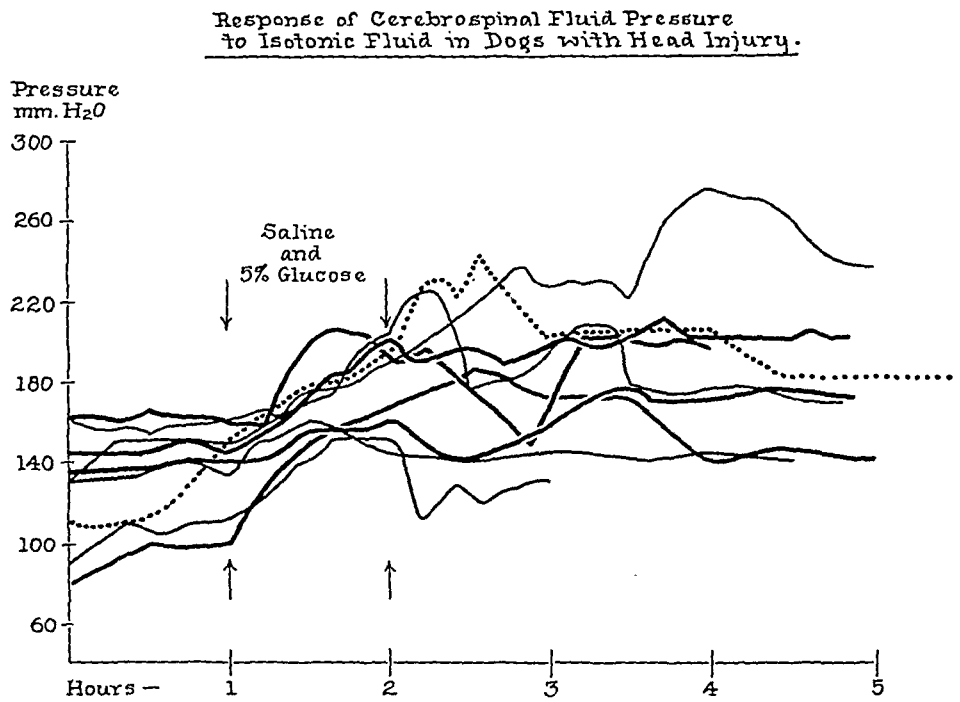


CHART 6.

of one hour, an increase in cerebrospinal fluid pressure was, as a rule, observed, as shown in Chart 6. The final mean increase in pressure was 37 Mm. of spinal fluid. The average urinary excretion of five dogs receiving physiologic saline solution was 16 cc. per Kg. during the experimental period. Normal dogs under the same conditions excreted 16.1 cc. per Kg.

The intravenous administration of 50 per cent glucose solution produced a fall in the cerebrospinal fluid pressure. In no instance was a secondary rise in pressure encountered. Death occurred in two animals following the administration of the glucose solution while the pressure was being measured. In neither case did a rise in the pressure occur. Chart 7 shows the cerebrospinal fluid pressure changes which were observed.

The average urinary excretion in the traumatized group following the injection of hypertonic glucose solution was 22 cc. per Kg. over the period of the experiment. Normal animals receiving 50 per cent glucose solution averaged 23.7 cc. of urine.

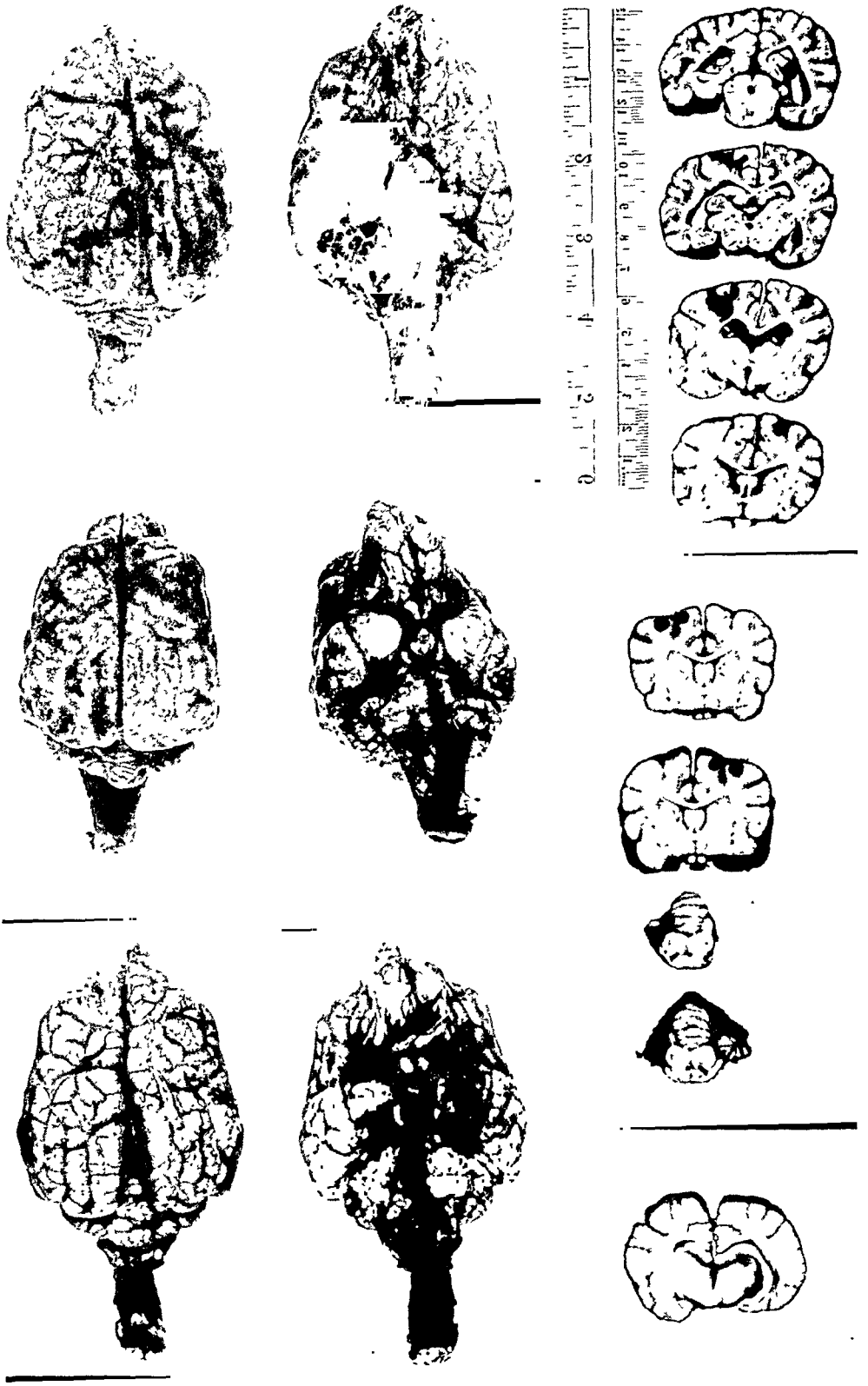


PLATE I

EXAMPLES OF TYPE OF INJURY RESULTING IN MARKEDLY BLOODY CEREBROSPINAL FLUID; INCREASE IN CEREBROSPINAL FLUID, AND DEATH.

Dog No. 92—Pressure 240 Mm.—Glucose experiment
Dog No. 472—Pressure 285 Mm.—Glucose experiment
Dog No. 372—Pressure 450 Mm.—Glucose experiment

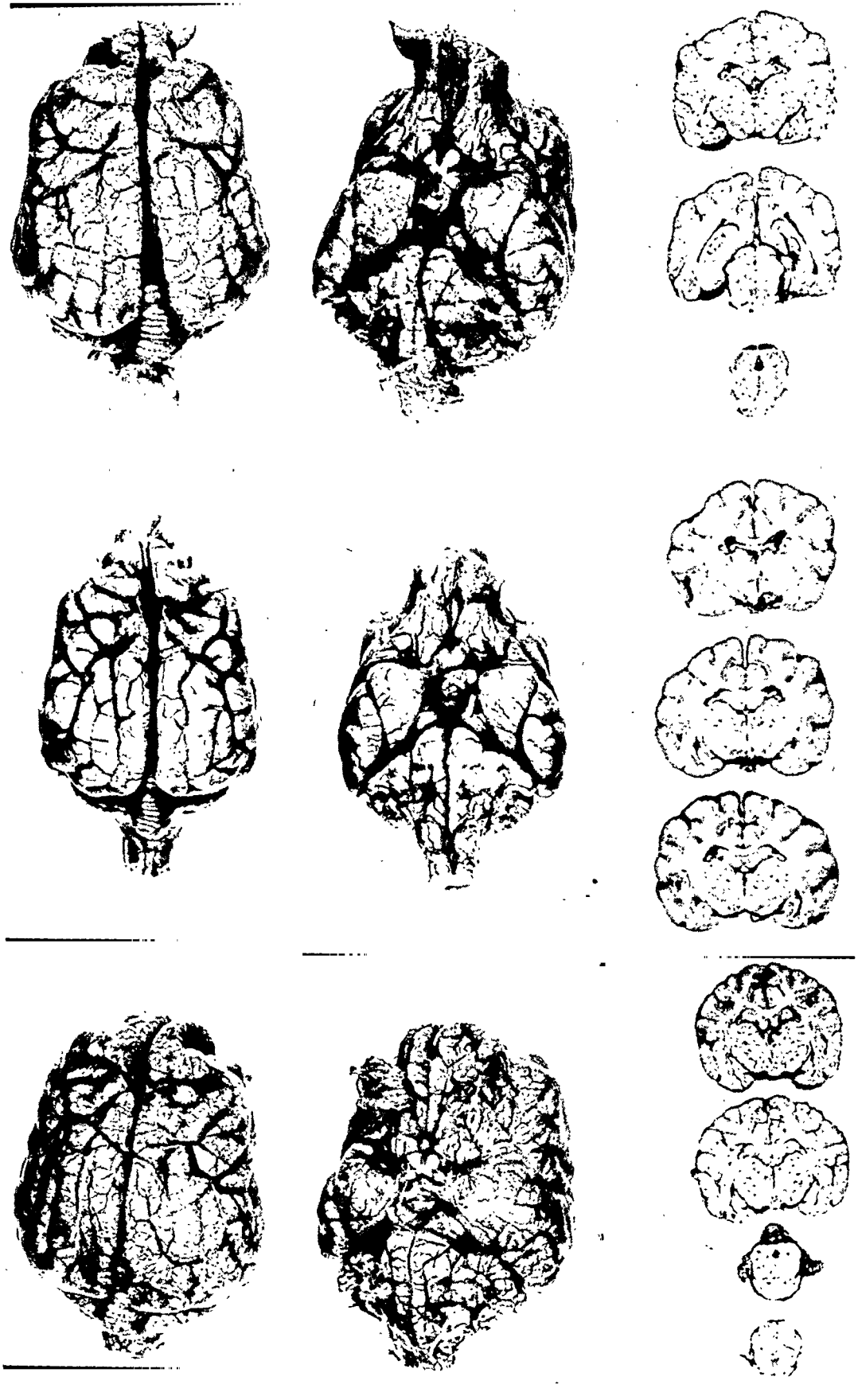


PLATE II

EXAMPLES OF THE TYPE OF INJURY RESULTING IN BLOOD IN THE CEREBROSPINAL FLUID; LITTLE OR NO INCREASE IN THE CEREBROSPINAL FLUID; WITH SURVIVAL.

Dog	Pressure	Experiment
No. 672	140 Mm.	Control
No. 1	165 Mm.	Control
	165 Mm.	Saline
	140 Mm.	Saline
	155 Mm.	Glucose
No. 835	85 Mm.	Control
	85 Mm.	Control

The fluid intake was recorded for all the animals. In a number of instances the quantity of fluid was restricted. In others, a large volume of fluid was administered. Chart 8 shows that there was no correlation between the fluid intake and the cerebrospinal fluid pressure after trauma, in experiments during which the fluid, as a rule, was administered over a prolonged period of time.

Blood was present in the cerebrospinal fluid in 23 of the 30 animals subjected to trauma. Daily counts of the red and white blood cells in the spinal

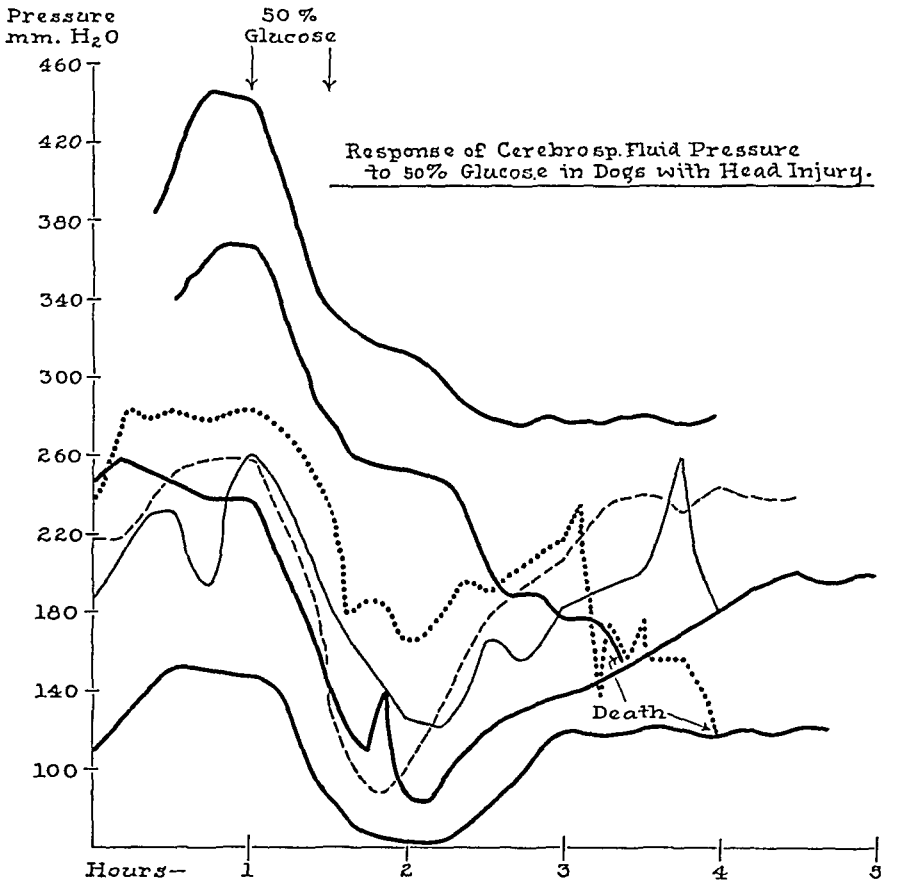


CHART 7.

fluid were made upon nine dogs that survived injury but which showed moderate or markedly bloody fluids. As shown in Chart 9, white blood cells were proportional to red blood cells in the ratio of 1:400, the same as that found in circulating blood. A progressive fall in the number of red blood cells and a proportionate decrease in the number of white blood cells occurred after trauma. Between the fourth and sixth day after injury, the fluid contained up to 40 white blood cells. In one instance, in which a cortical laceration of the brain was produced by the trauma, the number of white blood cells in the cerebrospinal fluid exceeded the proportionate number, as previously described, to a significant degree.

There was a correlation between the amount of blood in the cerebrospinal

fluid and the cerebrospinal fluid pressure when the red blood cells exceeded one million, as shown in Chart 10. All but one of the fatalities occurred in the group of dogs having a high red cell count in the cerebrospinal fluid.

Discussion.—In experiments which have already been reported,[22] the mean cerebrospinal fluid pressure of the normal, unanesthetized dog was found to be 123 Mm. of spinal fluid. In our studies on dogs with head injuries, the mean pressure was 151 Mm., and was less than 200 Mm. in 80 per cent of the experiments. These findings are in agreement with those previously

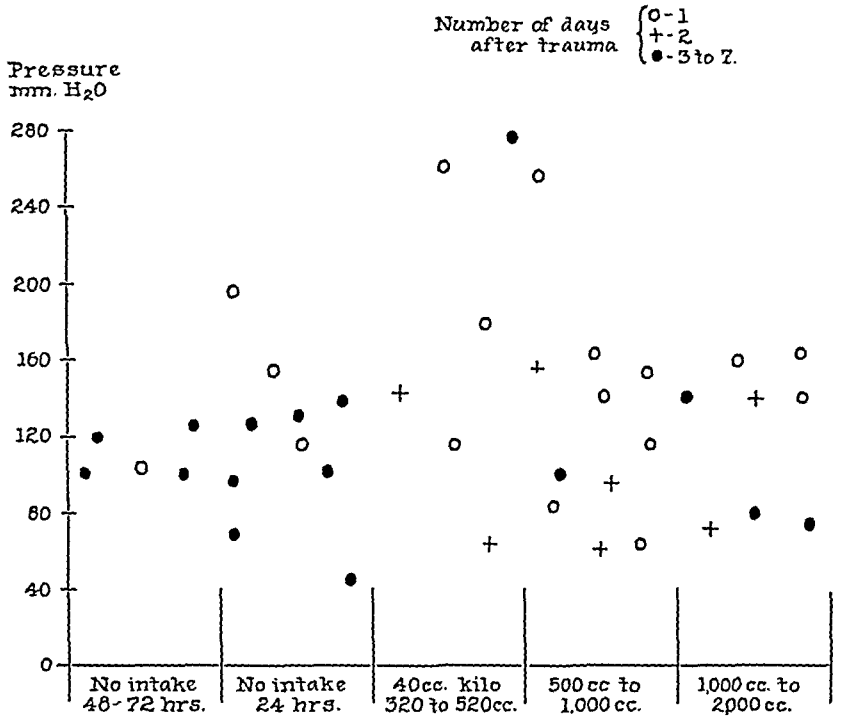


CHART 8.—Illustrating the absence of correlation between the intake of fluid and the cerebrospinal fluid pressure in dogs with head injury. Fluid was administered or withheld over a period of 24 hours, except as indicated. At the end of this period, the cerebrospinal fluid pressure was measured.

reported by Gurdjian, Webster and Sprunk[12] in patients with head injuries. Our observations indicate that the cerebrospinal fluid pressure was not significantly elevated in most instances of cranial injury both in the experimental animal and the human.

No correlation was observed between the fluid intake and the cerebrospinal fluid pressure in dogs with such injuries. In two of the animals all food and water was withheld for 72 hours, with resultant weight loss, and elevation of the serum protein. No significant change in the cerebrospinal fluid pressure occurred.

Dehydration therapy, suggested by Fay,[9] is accomplished by the limitation of fluid intake to 20 ounces of water daily; the use of intravenous glucose solution, and the withdrawal of spinal fluid. Increased intracranial pressure is said to be avoided by these measures. However, the stability of the cerebrospinal fluid pressure may account for the fact that the results of treatment

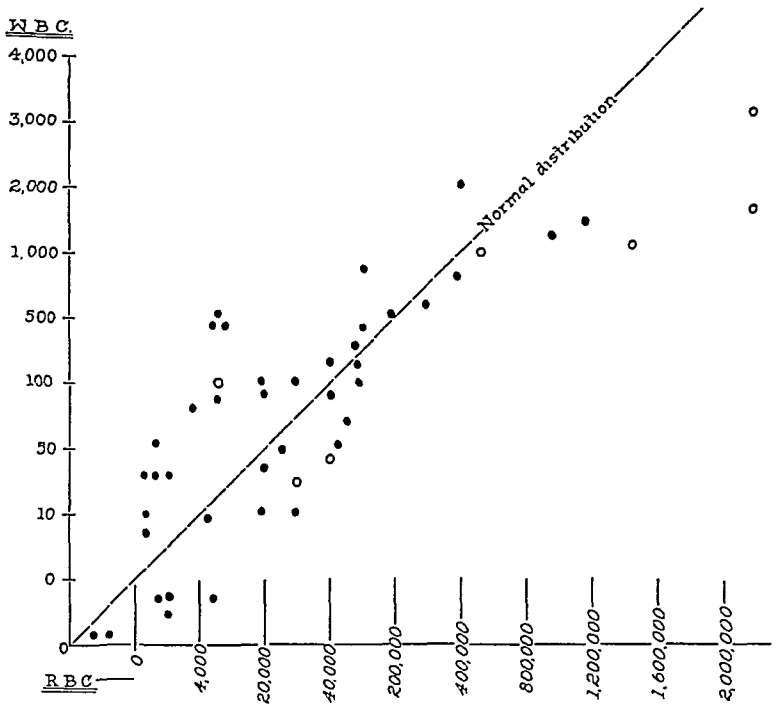


CHART 9.—Illustrating the correlation found between the number of red cells and white blood cells in the cerebrospinal fluids which were bloody after cranial trauma. Counts were made on the day of injury and on subsequent days.

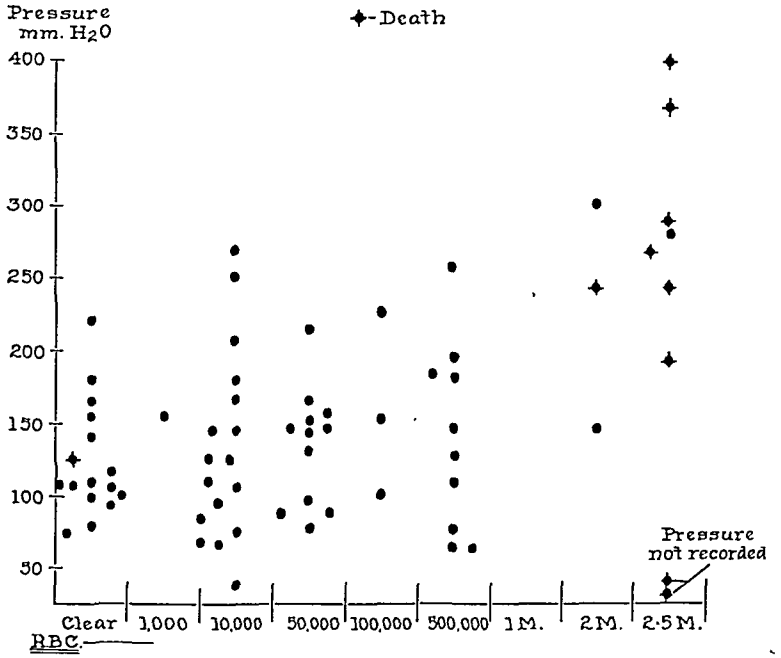


CHART 10.—Illustrating the correlation of death of the animals with the degree of bloodiness of the cerebrospinal fluid, and the cerebrospinal fluid pressure.

of patients with cranial injury by dehydration are no different from those obtained by other methods of treatment.

If it is desirable to lower the increased intracranial pressure, which may or may not be present in cases of cerebral trauma, the question may be raised as to the effectiveness of restriction of fluid to accomplish this end. On the other hand, it does not appear reasonable to fear that an adequate intake of fluid will have an unfavorable effect upon the patient by significantly increasing the intracranial pressure.

The injection of 50 per cent glucose solution intravenously in animals with the severest head injuries, and with the highest cerebrospinal fluid pressure which we encountered, resulted in a fall of the pressure in each instance. No secondary rise in pressure was observed. Browder,[2] Jackson,[14] and others have reported a secondary rise in pressure following the administration of 50 per cent glucose solution to humans with cranial trauma.

No meningeal reaction as indicated by an increase in the number of white blood cells in the cerebrospinal fluid was observed to be caused by blood in the cerebrospinal fluid. Essick,[8] in experiments showing the reaction of the arachnoid to particulate matter, found that blood injected into the subarachnoid space produced a marked pleocytosis. Weed[25] restated the findings of Essick, and described further experiments dealing with the effects of other particulate matter. Bagley[1] showed significant late pathologic changes resulting from the injection of blood into the cerebrospinal fluid.

Our findings differ from those of Essick, but agree with observations made by Merritt and Fremont-Smith.[19] The latter noted that in 26 cases of subdural hematomata, with blood in the spinal fluid, the number of white blood cells was, with few exceptions, proportional to the number of red blood cells.

A reason for the above discrepancy in findings may be found in the experimental technic employed by Essick, which consisted in laking blood with distilled water. Sodium chloride was then added to make an isotonic solution before it was injected into the cisterna of the animal. The injection of this solution resulted in a "sterile meningitis" within a few hours. In our experience, the injection of physiologic saline solution into the cisterna, or even the use of saline solution in a manometer to measure the cerebrospinal fluid pressure, results in a reaction similar to that encountered by Essick. The effect of saline solution in a manometer to measure the cerebrospinal fluid pressure has been reported upon in a previous publication.[22]

Doubt has arisen as to the etiologic significance of increased intracranial pressure in deaths due to head injury. From the experimental standpoint, the cerebrospinal fluid pressure must equal or exceed the diastolic blood pressure in order to produce profound effects upon the organism.[5] Cerebrospinal fluid pressure in such a range has not been observed.[4, 12] From the clinical standpoint, operative treatment aimed at the relief of increased intracranial pressure in patients with fractured skulls has been found to be unnecessary and even dangerous. Dehydration therapy has not yielded striking

benefits in clinical cases. The rationale of treatment based upon reduction of the intracranial pressure may, therefore, be questioned.

Two additional relationships may be of greater significance: First, the degree of bloodiness of the cerebrospinal fluid was found to be closely correlated with the death of the animals in our experiments. Of ten animals that died following injury, nine had markedly bloody cerebrospinal fluid containing one to five million red blood cells. A second correlation was found between the quantity of blood in the cerebrospinal fluid and the increase in the cerebrospinal fluid pressure that occurred. The greater the degree of bloodiness of the spinal fluid, the higher was the cerebrospinal fluid pressure, as shown in Chart 10. Deaths, therefore, might have occurred not because of the increased intracranial pressure itself but rather as a result of the severity of the brain injury as reflected by the quantity of blood in the cerebrospinal fluid. In our opinion, treatment directed merely toward removing the red blood cells from the cerebrospinal fluid or reducing its pressure, incidents resulting from the cerebral damage, is of questionable value.

CONCLUSIONS

Dogs which sustained severe head injuries were found to have cerebrospinal fluid pressure which were less than 200 Mm. in 80 per cent of the cases, and more than 200 Mm. in 20 per cent.

The intravenous administration of isotonic fluids produced a moderate increase in the cerebrospinal fluid pressure. The state of hydration or dehydration, as indicated by fluid intake, had no significant effect on the cerebrospinal fluid pressure after head injury.

Fifty per cent glucose solution administered intravenously lowered the cerebrospinal fluid pressure in all instances. No secondary rise in pressure was observed.

The presence of blood in the cerebrospinal fluid following head injuries in dogs did not produce an increase in the number of white blood cells above the proportionate number.

When the cerebrospinal fluid contained red blood cells, amounting to two million or more, the cerebrospinal fluid pressure was elevated, and the mortality was 75 per cent.

The ultimate outcome of dogs with head injuries was more clearly correlated with the degree of damage to the nervous system, expressed by the presence of blood in the cerebrospinal fluid, than with the elevation of the cerebrospinal fluid pressure.

The authors wish to express their appreciation for the assistance accorded them by Miss Elizabeth Thorogood and Dr. C. C. Miller, and for the suggestions and cooperation of Drs. I. S. Ravdin and F. C. Grant.

BIBLIOGRAPHY

[1] Bagley, C., Jr.: Blood in the Cerebrospinal Fluid; Resultant Functional and Organic Alterations in the Central Nervous System. Arch. Surg., 17, 39, 1928.

[2] Browder, J.: Dangers in the Use of Hypertonic Solutions in the Treatment of Brain Injuries. Am. Jour. Surg., 8, 1213, 1930.

[3] Bullock, L. T., Gregersen, M. I., and Kinney, R.: The Use of Hypertonic Sucrose Solution Intravenously to Reduce Cerebrospinal Fluid Pressure Without a Secondary Rise. Am. Jour. Physiol., 112, 82, 1935.

[4] Cannon, W. B.: Cerebral Pressure Following Trauma. Am. Jour. Physiol., 6, 91, 1901.

[5] Cushing, H.: Concerning a Definite Regulatory Mechanism of the Vasomotor Center Which Controls Blood Pressure During Central Compression. Bull. Johns Hopkins Hosp., 12, 290, 1901.

[6] Dixon, W. E., and Halliburton, W. D.: The Cerebrospinal Pressure. Jour. Physiol., 48, 128, 1914.

[7] Ebaugh, F. G., and Stevenson, G. S.: The Measurements of Intracranial Pressure Changes in an Epileptic and Its Experimental Variation. Bull. Johns Hopkins Hosp., 31, 440, 1920.

[8] Essick, C. R.: Formation of Macrophages by the Cells Lining the Subarachnoid Cavity in Response to the Stimulus of Particulate Matter. Contrib. Embryol., No. 42. Carnegie Inst. of Washington, Publ., Nos. 272 and 377, 1920.

[9] Fay, T.: The Treatment of Acute and Chronic Cases of Cerebral Trauma by Methods of Dehydration. Annals of Surgery, 101, 76, 1935.

[10] Foley, F. E. B., and Putman, T. J.: The Effect of Salt Ingestion on Cerebrospinal Fluid Pressure and Brain Volume. Am. Jour. Physiol., 53, 464, 1920.

[11] Fremont-Smith, F., and Merritt, H. H.: Influence of Variations in the Fluid Intake on Intracranial Pressure in "Epileptics." Arch. Neurol. and Psychiat., 29, 454, 1933.

[12] Gurdjian, E. S., Webster, J. E., and Sprunk, C.: Studies of the Spinal Fluid in Cases of Injury to the Head. Arch. Neurol. and Psychiat., 42, 92, 1939.

[13] Howe, H. S.: Experimental Studies in Reduction of the Normal Cerebrospinal Fluid Pressure in Cats by the Intravenous Administration of Hypertonic Solutions. Arch. Neurol. and Psychiat., 14, 315, 1925.

[14] Jackson, H., Kutsuani, T., Leader, L. O., and Joseph, L. D.: Effect of Hypertonic Dextrose Solutions on Intracranial Pressure in Acute Cranial Injuries. J.A.M.A., 100, 731, 1933.

[15] Lehman, E. P., and Parker, W. H.: The Unsolved Problems of Brain Injury. Internat. Clin., 3, 180, 1935.

[16] Masserman, J. H.: Cerebrospinal Fluid Hydrodynamics: Effect of Drainage. Arch. Neurol. and Psychiat., 32, 523, 1934.

[17] Masserman, J. H.: Effects of Intravenous Administration of Hypertonic Solutions of Dextrose. J.A.M.A., 102, 2084, 1934.

[18] Masserman, J. H.: Effects of Intravenous Administration of Hypertonic Solutions of Sucrose. Bull. Johns Hopkins Hosp., 57, 12, 1935.

[19] Merritt, H. H., and Fremont-Smith, F.: The Cerebrospinal Fluid. Philadelphia, W. B. Saunders Co., 1937.

[20] Milles, G., and Hurwitz, P.: The Effect of Hypertonic Glucose on the Cerebrospinal Fluid Pressure: With Special Reference to the Secondary Rise and Toxicity. Arch. Surg., 24, 591, 1932.

[21] Munro, D.: Craniocerebral Injuries. Oxford University Press, N. Y., 1938.

[22] Webster, J. E., and Freeman, N. E.: Studies on the Cerebrospinal Fluid Pressure in Unanesthetized Dogs: (I) Physiologic Responses to the Administration of Intravenous Fluids in Normal Animals. Annals of Surgery, 113, 556, 1941.

[23] Weed, L. H., and McKibbon, P. S.: Pressure Changes in the Cerebrospinal Fluid Following Intravenous Injections of Solutions of Various Concentrations. Am. Jour. Physiol., 48, 512, 1919.

[24] Weed, L. H., and Hughson, W.: Systemic Effects of the Intravenous Administration of Solutions of Various Concentrations with Especial Reference to the Cerebrospinal Fluid. Am. Jour. Physiol., 58, 53, 1921.

[25] Weed, L. H.: The Cells of the Arachnoid. Bull. Johns Hopkins Hospital, 31, 343, 1920.

THE INDUCTION OF LIVER NECROSIS IN RABBITS BY THE COMBINATION OF EXPERIMENTAL HYPERTHYROIDISM AND SHOPE PAPILLOMA

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THE INFLUENCE of hyperthyroidism in the morphologic and physiologic alteration of the liver has long been recognized. Habersohn,[1] in 1874, noted jaundice in patients with hyperthyroidism. Marine and Lenhart,[2] in a study of pathologic anatomy of the toxic goiter, called attention to scarring of the liver in this disease. Barker[3] reported a case of advanced central necrosis in the liver of a patient dying from hyperthyroidism. In 1932, Weller[4] cited the hepatic changes in 48 cases of Graves' disease in which all other possible causes of damage were excluded. He described marked chronic hepatitis in 26 cases, slight chronic hepatitis in 16, and no lesions in six. Beaver and Pemberton,[5] in 1933, collected 107 cases of hyperthyroidism coming to autopsy at the Mayo Clinic, describing in the liver: (1) Acute degenerative changes; (2) simple atrophy; and (3) subacute toxic atrophy and toxic cirrhosis. Cameron and Karunaratne[6] reported 30 cases of hyperthyroidism and observed the hepatic changes described by other authors.

Clinical evidence of disturbed liver function in hyperthyroidism has been reported by many authors. Youmans and Warfield,[7] using the phenoltetrachlorphthalein test, found hepatic damage in 22 of 44 persons who had hyperthyroidism. Maddock, Coller and Pederson[8] reported eight out of 13 cases of toxic goiter with evidence of liver damage, as tested by serum bilirubin and bromsulphalein determinations. Bartels[9] reported 148 cases of hyperthyroidism that were subjected to the Quick hippuric acid test, and all but 18 showed evidence of impaired liver function.

The experimental production of liver necrosis has been attempted by many workers. Farrant,[10] in 1912, described central fatty changes in liver of cats and rabbits that were fed desiccated thyroid until death was produced. In 1921, Hashimoto,[11] while working with rats and studying the effect of desiccated thyroid on heart muscle, described central necrosis of the liver. It is interesting that the incidence of pneumonia in his group of animals was 85 per cent, but no attempt was made to correlate this complication with the cardiac or hepatic changes. Gerlei,[12] in 1933, and Sciaky,[13] in 1936, described liver necrosis in rabbits following the injection of thyroxin. Goodpasture,[14] in 1921, while studying the effect of experimental hyperthyroidism induced by thyroxin and desiccated thyroid on the heart muscle of rabbits, in combination with chloroform inhalation, did not observe any necrosis of liver with thyroxin alone or in combination with small amounts of chloroform. Cameron and Karunaratne,[6] using rats, were not able to produce liver necrosis

Submitted for publication July 2, 1940.

with thyroxin. Davis and Whipple[15] could not detect any increased necrosis when desiccated thyroid was fed to animals along with chloroform. Haban,[16] in 1935, fed rabbits desiccated thyroid and thyroxin, and called attention to the presence of central necrosis in four out of seven rabbits, all four having an acute intercurrent infection. He concluded that a combination of hyperthyroidism and infection was necessary to cause liver necrosis. The necessity of a factor other than hyperthyroidism in the production of lesions of the heart muscle has been demonstrated by Goodpasture,[14] using thyroxin and chloroform, and by Schultz,[17] using thyroxin and desiccated thyroid plus a chronic streptococcic infection.

In a further study to determine the effects of experimental hyperthyroidism on the liver, rabbits having sloughing infected skin tumors (Shope papillomata) were used, and widespread central necrosis was found. This change in the liver could not be produced by experimental hyperthyroidism in normal rabbits, nor was it present in rabbits having only Shope papilloma and not fed desiccated thyroid. A report of this study follows.

In this investigation 41 rabbits were used. The first group consisted of rabbits presenting multiple sloughing infected skin tumors resulting from infection with the Shope papilloma virus and in which hyperthyroidism was produced by desiccated thyroid; the second group were normal stock animals given desiccated thyroid in exactly the same manner as Group I; and the third group showed skin lesions similar to Group I and were killed, as controls, without the administration of desiccated thyroid.

Armour's desiccated thyroid, U.S.P., prepared in 0.128 Gm. tablets, was used throughout the experiment; the tablets being fed either dry or in a suspension of tap water each evening. The use of desiccated thyroid has been employed by many workers and found to induce experimental hyperthyroidism,[10, 16, 17] with the weight loss being a satisfactory index of the degree of toxicity.[10, 16] The rabbits were all kept in separate cages and fed a diet of cabbage, oats, and rabbit chow.

Except in the ones indicated in Table II, all the thyroid-fed rabbits were allowed to die or to reach such a critical stage that it was deemed advisable to kill them. The sections were fixed with Zenker's solution and stained with hematoxylin and eosin.

The control papilloma animals were sacrificed by either a blow on the head or by injection of air into the ear vein, with the tissues fixed and stained in the same manner already described.

The Shope papilloma is a cutaneous "warty" growth that is easily induced in domestic rabbits by a virus isolated from wild rabbits.[18] The behavior of the tumor on the host is typical of any rapidly progressive new growth on the body surface in that its size soon exceeds the blood supply; and, as a sequela of this as well as a result of trauma, necrosis and secondary infection follow. The effect of the tumor on the host is not marked except in the occasional growth that progresses to malignancy as has been reported by Rous and Beard.[19] From eight to 12 weeks before these experiments were begun the rabbits used in Groups I and III had received multiple skin inoculations with

the purified virus protein derived from the Shope papillomata during an experiment conducted by Drs. W. R. Bryan and J. W. Beard.[20] Following these inoculations, from five to 15 papillomata developed on each animal, measuring from 3 to 5 cm. in diameter, all showing some necrosis and secondary infection.

GROUP I.—There were 15 domestic rabbits that had been inoculated with the Shope papilloma virus, as described, in which experimental hyperthyroidism was produced by desiccated thyroid. Table I shows the initial weight, the weight loss, the amount of desiccated thyroid given per day, the number of days the preparation was administered, and the survival period of each animal.

TABLE I

SUMMARY OF RABBITS INFECTED WITH SHOPE PAPILLOMA VIRUS RECEIVING DESICCATED THYROID

Rabbit No	Condition at Beginning of Experiment	Amt. of Desiccated Thyroid per Day in Gm	No of Days Fed Desiccated Thyroid	Days Before Death	Wt in Gm. Beginning of Experiment	Wt. Loss in Gm.	Liver Changes	Other Changes
918	Fair	0 128	6	7	2,400	350	++++	Pneumonia
917	Fair	0 128	32	33	2,075	600	0	0
921	Fair	0 512	14	15	2,250	925	++++	Pneumonia
943	Poor	0 512	2	3	2,100	375	++++	Pneumonia
914	Fair	0 768	8	9	2,050	600	0	0
969	Good	0 768	6	7	2,600	575	+++	0
1242	Good	0 768	6	7	1,900	450	+	0
1249	Poor	0 768	2	3	1,500	250	+++	0
1252	Good	0 768	3	4	2,100	350	+++	Purulent pericarditis
1839	Good	0 768	3	4	1,850	350	++	0
1885	Good	0 768	3	4	2,125	375	++	0
2005	Good	0 768	2	3	2,100	400	+	0
2278	Good	0 768	6	7	1,850	450	+	0
2267	Good	0 768	5	6	2,250	500	++++	0
2276	Fair	0 768	3	4	1,650	200	0	0

Twelve of the 15 animals in this group showed liver necrosis, central in type, with an occasional involvement of the midzonal area. This was accompanied by cellular infiltration. The extent of the process varied from small areas around the central vein to two-thirds of the liver lobule. The microscopic picture was no different from that seen in necrosis from other toxic agents. A description and photomicrographs of sections from the livers of two rabbits are included.

Rabbit No. 943.—The microscopic study of the liver shows widespread central necrosis with an occasional area of midzonal involvement accompanied by slight cellular infiltration. A minimal amount of fatty change is present in some locations. Passive congestion and changes about the portal areas are not present (Fig. 1).

Rabbit No. 1839.—Except for the degree, the microscopic changes are essentially the same as in Rabbit No. 943. The necrosis is in the same location but not nearly so extensive, while the cellular infiltration is much more extensive (Fig. 2).

In grading the degree of necrosis present in the livers of the rabbits in Group I, the designations one plus, two plus, three plus, and four plus were used. Fig. 1 illustrates the change classified as four plus, and Fig. 2 that classified as two plus.



FIG. 1.—Rabbit No. 943: Photomicrograph showing widespread necrosis of the liver in rabbits presenting multiple necrotic and infected skin tumors (Shope papillomata) three days after the induction of experimental hyperthyroidism (×150).

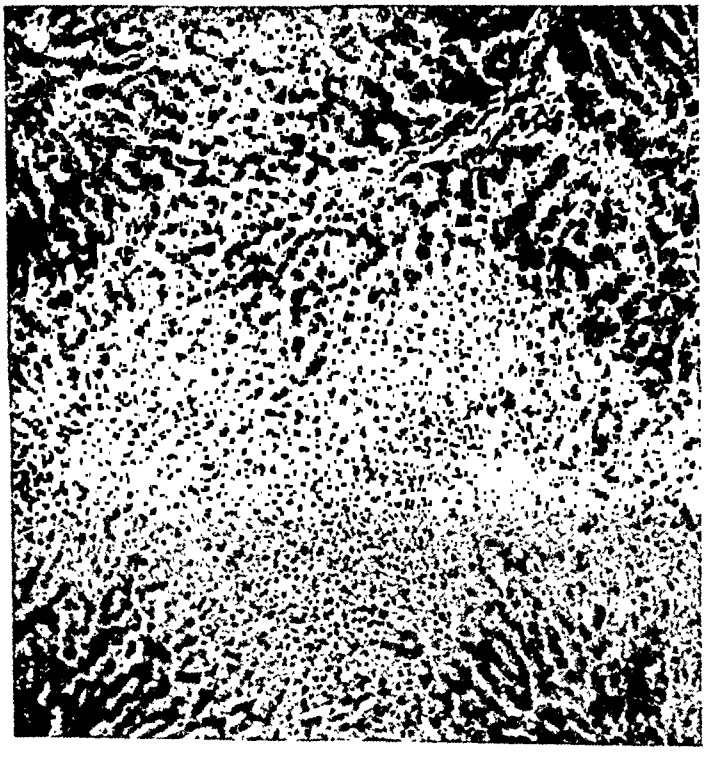


FIG. 2.—Rabbit No. 1839: Photomicrograph showing central necrosis of the liver with polymorphonuclear infiltration in a rabbit presenting multiple necrotic and infected skin tumors (Shope papillomata) four days after the induction of experimental hyperthyroidism (×150).

GROUP II.—Fifteen normal rabbits were in this group. Hyperthyroidism was produced exactly as in Group I. With the exception of the three rabbits killed at the end of three days and two rabbits killed at the end of two days, without regard to their general condition, all were allowed to die from the effects of the desiccated thyroid. Four rabbits of this group received 20 cc. of 20 per cent ethyl alcohol daily by mouth in addition to the desiccated thyroid. None of the livers in this group showed any significant changes. The data are summarized in Table II.

TABLE II

SUMMARY OF NORMAL RABBITS FED DESICCATED THYROID

Rabbit No.	Condition at Beginning of Experiment	Amt. of Desiccated Thyroid per Day in Gm.	No. of Days Fed Desiccated Thyroid	Days Before Death	Wt. in Gm. Beginning of Experiment	Wt. Loss in Gm.	Liver Changes	Other Changes
238	Good	0.128	32	33	2,075	600	0	0
237	Good	0 512	21	22	2,100	825	0	0
239	Good	0.768	11	12	1,900	775	0	0
406	Good	0.768	6	7	2,200	725	0	0
409	Good	0.768	13	14	1,850	475	0	0
403	Good	0 768	15	16	2,100	675	0	0
402(A)*	Good	0.768	3	4	2,000	150	0	0
405(A)	Good	0.768	3	4	2,300	250	0	0
408(B)†	Good	0.768	3	4	1,725	175	0	0
401(B)	Good	0 768	6	7	1,875	400	0	0
404(B)	Good	0.768	6	7	1,800	325	0	0
3(C)‡	Good	0.512	5	6	2,000	500	0	0
4(C)	Good	0.512	8	9	2,050	650	0	0
5(C)	Good	0.512	9	10	2,675	725	0	0
6(C)	Good	0 512	8	9	2,275	1,025	0	0

*(A) Killed at end of four days without regard to general condition.
†(B) Killed at end of seven days without regard to general condition.
‡(C) In addition to desiccated thyroid received 20 cc. of 20 per cent ethyl alcohol per day.

GROUP III.—Eleven rabbits having Shope papillomata, in all respects similar to those in Group I but not fed desiccated thyroid, were killed as controls to determine if the papillomata alone had any effect on the liver. In no case was there any change other than an occasional focal area of fatty change (Table III).

Discussion.—These experiments demonstrate that liver necrosis can only be produced with desiccated thyroid when there is a second factor present, in this instance the Shope papilloma. This conception of the summation or combination of factors is not new, as Opie,[21] in 1910, noted that the combination of small amounts of either chloroform or phosphorus with intravenous injections of bacteria produced profound liver necrosis beyond that expected from either factor alone. Desiccated thyroid is capable of producing a marked rise in the metabolism of cells, and this increase can be carried to the point of exhaustion, as illustrated in Group II where normal rabbits were used. That this is not sufficient to induce cellular necrosis is clearly shown in the postmortem studies of Group II.

The Shope papilloma is a skin tumor that in this experiment was allowed to reach considerable size and to remain on the host for two to three months. During this time necrosis and secondary infection had resulted. It is prob-

able that products from tumor tissue necrosis and bacterial infection are absorbed; but as shown in Group III, these products do not affect the microscopic appearance of the liver.

TABLE III

SUMMARY OF RABBITS PRESENTING SHOPE PAPILLOMATA AND NOT RECEIVING DESICCATED THYROID

Rabbit No.	Liver Changes	Other Changes
1247	0	0
1269	0	Paralysis of bladder Marked cystitis
1245	0	0
1240	0	0
1893	0	Pneumonia
1895	0	0
2001	0	0
2003	0	0
2279	0	0
2270	0	Pneumonia
2077	0	0

The second factor is not the virus itself as the extracts from these papillomata on domestic rabbits are not infectious,[18] nor could Beard and Wyckoff[22] demonstrate the virus protein in the tumor extracts by the ultracentrifuge. Thus it is suggested that products resulting from papillomata, whether from tumor necrosis or infection, combined with the increased metabolism cause liver necrosis. It is possible that the metabolism of the cells is thus so greatly stepped-up that the point of exhaustion is reached, and substances once easily detoxified by the liver, now are capable of producing cellular necrosis.

In addition to the necrosis and infection in the papillomata, four of the 15 rabbits in Group I had an acute intercurrent infection; and in each of these the liver showed extensive necrosis. On the other hand, in the control papillomata group three animals with intercurrent infections in addition to the papillomata did not show significant liver changes. This suggests that the liver necrosis produced by the combination of hyperthyroidism and the Shope papillomata is increased by presence of an acute infection.[16]

Another interesting point is the relation of the liver necrosis and the decrease of liver cell glycogen caused by experimental hyperthyroidism. This glycogen loss renders the cell more susceptible to any toxic agent, which in this case may be products of necrosis and infection from the papilloma.

The clinical significance of the above is evident when one considers that in deaths from hyperthyroidism there is often a complicating factor, such as (1) anesthetic agents with or without accompanying anoxemia; (2) an acute intercurrent infection; and (3) the absorption from the operative site of the products resulting from trauma and bacterial contaminants. One or more of these factors combined with hyperthyroidism may well account for cases of liver necrosis observed by authors reporting human autopsy material. Further work on this subject is now in progress.

CONCLUSIONS

(1) Liver necrosis was produced in 12 of 15 rabbits having necrotic, infected, cutaneous "warty" growths (Shope papillomata) by experimental hyperthyroidism induced with desiccated thyroid.

(2) Liver necrosis was not present in 15 normal rabbits after a similar degree of hyperthyroidism had been produced with desiccated thyroid.

(3) Liver necrosis was not present in 11 rabbits having necrotic, infected, cutaneous "warty" growths (Shope papillomata) in which hyperthyroidism was not induced.

BIBLIOGRAPHY

[1] Habersohn, S. O.: Exophthalmic Goitre, Heart Disease, Jaundice, Death. Lancet, 1, 510, April, 1874.

[2] Marine, D., and Lenhart, C. H.: Pathological Anatomy of Exophthalmic Goitre: The Anatomical and Physiological Relationship of the Thyroid Gland to the Disease, the Treatment. Arch. Int. Med., 8, 265–316, September, 1911.

[3] Barker, L. F.: Thyreo-Intoxication with Necrosis and Atrophy of Liver, Damage to Heart Muscle and Kidneys, and Terminal Bronchopneumonia. Med. Clin. North America, 14, 261–263, 1920.

[4] Weller, C. V.: Hepatic Pathology in Exophthalmic Goitre. Ann. Int. Med., 7, 543–560, November, 1933.

[5] Beaver, D. C., and Pemberton, J. de J.: The Pathologic Anatomy of the Liver in Exophthalmic Goitre. Ann. Int. Med., 7, 687–708, December, 1933.

[6] Cameron, G. R., and Karunaratne, W. A. E.: Liver Changes in Exophthalmic Goitre. Jour. Path. and Bact., 41, 267–282, September, 1935.

[7] Youmans, J. B., and Warfield, L. M.: Liver Injury in Thyrotoxicosis as Evidenced by Decreased Functional Efficiency. Arch. Int. Med., 37, 1–17, January, 1926.

[8] Maddock, W. G., Coller, F. A., and Pedersen, S.: Studies of the Blood Chemistry in Thyroid Crisis. J.A.M.A., 109, 2130–2135, December, 1937.

[9] Bartels, E. C.: Liver Function in Hyperthyroidism as Determined by Hippuric Acid Test. Ann. Int. Med., 12, 652–674, November, 1938.

[10] Farrant, R.: Hyperthyroidism, Its Experimental Production in Animals. Brit. Med. Jour., 2, 1363–1367, November, 1913.

[11] Hashimoto, H.: The Heart in Experimental Hyperthyroidism with Special Reference to Its Histology. Endocrinology, 5, 579–606, September, 1921.

[12] Gerlei, F.: Necrose du Faie Consecutive à l'Empaisannement par la Thyroxine. Ann. d'Anat. Path., 15, 165–199, February, 1938.

[13] Sciaky, I.: Hyperthyroidism experimental chez deffèrentes especes animals. Ann. d'Anat. Path., 15, 165–199, Febrary, 1938.

[14] Goodpasture, E. W.: Influence of Thyroid Products on Production of Myocardial Necrosis. Jour. Exper. Med., 34, 407, October, 1921.

[15] Davis, N. G., and Whipple, G. H.: The Influence of Fasting and Various Diets on Liver Injury Effected by Chloroform Anesthesia. Arch. Int. Med., 23, 612–635, May, 1919.

[16] Haban, G.: Leberneranderungen bei experimentellem Hyperthyroidismus. Beitr. path. Anat. u. allg. Path., 95, 579–589, September, 1935.

[17] Schultz, N. P.: The Induction of Carditis by the Combined Effects of Hyperthyroidism and Infection. Public Health Rep., 54, 1205–1228, July, 1939.

[18] Shope, R. E.: Infectious Papillomatosis of Rabbits. Jour. Exper. Med., 58, 607–624, November, 1933.

[19] Rous, P., and Beard, J. W.: A Virus-Induced Mammalian Growth with Characters of a Tumor (Shope Papilloma). Jour. Exper. Med., 60, 701–766, December, 1934.

[20] Bryan, W. R., and Beard, J. W.: The Estimation of Purified Virus Protein by Infectivity Measurements. Jour. Inf. Dis., 65, 306–321, November–December, 1939.

[21] Opie, E. L.: On Relation of Combined Intoxication and Bacterial Infection to Necrosis of the Liver, Acute Yellow Atrophy, and Cirrhosis. Jour. Exper. Med., 12, 367–387, May, 1910.

[22] Beard, J. W., and Wyckoff, R. W. G.: The Isolation of a Homogeneous Heavy Protein from Virus-induced Rabbit Papillomas. Science, 85, 201–202, February, 1937.

PERINEAL PROSTATOTOMY AND PROSTATECTOMY FOR THE REMOVAL OF PROSTATIC CALCULI*

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CALCULI of the prostate have been known from the early days of modern medicine, and their existence has raised problems with reference to both the diagnosis and treatment. With the advent of radiography, and especially of urography, their shadow-casts became familiar to urologists, and their diagnosis was lifted out of the obscurity in which it was formerly enshrouded. In the last few decades, these calculi have accordingly received considerable attention in the medical literature, which has revealed that they are far more common than had been believed. In fact, in routine postmortem examination, prostatic calculi of one type or another have been found by pathologists in approximately one out of every five individuals over 50 years of age, indicating that the condition of prostatolithiasis is pathologically very common. That they constitute an important chapter in the study of urology cannot be denied. The fact that great numbers of such stones run a symptomless course over a long period of time in no way detracts from their importance, since it is now recognized that the presence of a stone means the presence of infection, which tends sooner or later to excite inflammation and obstructive symptoms, as well as to serve as a focus for dissemination of pathogenic bacteria to other organs of the body.

Etiologically, these prostatic calculi fall into two distinct classes—the endogenous and the exogenous. *Endogenous* prostatic calculi develop primarily within the substance of the prostate gland, from slow deposit of calcium salts around the corpora amylacea found normally within the acini and tubules of the prostate. Just as these corpora are now known to be more abundant in men over the age of 50, it is likewise true that endogenous prostatic calculi are more commonly found in the later years of life, often in association with parenchymal prostatitis or adenomatous prostatic hypertrophy. In fact, during a perineal prostatectomy for such hypertrophy, it is quite common for the knife to encounter minute, multiple concretions that have not been previously suspected. The growth of such calculi is stimulated if they are so situated that urine has access to them, and they then tend to give rise to prostatic abscess and possible fistula or the formation of diverticula. In the group of *exogenous* prostatic calculi, on the other hand, are included those cases of the entire region of the prostatic urethra, in which a stone already formed in the upper part of the urinary tract enters the urethra and becomes wedged within the body of the prostate, lodged within one of its ducts or crypts, or in a diverticulum already present. Constant bathing with the urine as it escapes from the

* Read before the annual meeting of the American Urological Association, White Sulphur Springs, W. Va., *June 1, 1939*. Submitted for publication August 16, 1939.

bladder accelerates the growth and rapid development of these stones. It is possible also to recognize a *mixed* group of stones, which, beginning within the prostate, as endogenous, find their way through the mucosa of the urethra, and then become lodged where the urine contributes an exogenous element in the form of urinary salts, encouraging their growth and formation to such an extent that they may paradoxically be termed *endo-exogenous* prostatic calculi. The chemical analysis of such a stone will show that, while the outer covers or layers are of urinary salts, the nucleus is formed of the primary elements of the corpora amylacea.

Irrespective of their origin, all stones that are producing symptoms within the urinary tract call for surgical relief. The diagnosis is made on the basis of the roentgenographic and urographic findings, in conjunction with rectal and urethrocystoscopic exploration. When it becomes evident that the symptoms within the urinary tract are attributable to the presence of prostatolithiasis, *all stones within the region of the prostatic urethra fall, for practical purposes of treatment, into a single group.* All stones producing symptoms demand surgical removal. In the overwhelming majority of cases, such removal should be carried out by the perineal route. In some cases, however, other avenues of approach, such as the suprapubic or the transurethral operation may be indicated. Occasionally stones associated with obstructing median bars, lying close to the surface of the mucosa of the prostatic urethra, may call for endoscopic prostatic resection, but in most cases of multiple calculi the stones do not lie within the region that can be reached by this procedure, and many calculi are sure to be overlooked. A prostate full of stones can only be reached satisfactorily by way of the perineum, where the choice of operation will lie between perineal prostatotomy and perineal prostatectomy. A detailed discussion of their surgical management and their operative indications and results is herewith presented, with a view to offering a plea in behalf of a more extensive employment of open operative treatment in well-selected cases of this type of lithiasic disease (Fig. 1). It will be seen, from the various types of calculi of the prostate that I am exhibiting, what a wide range of possibilities in the mode of formation these cases may present. However, all alike demonstrate the superior advantages presented by the perineal approach when the choice of an operation is to be made. They also show the importance of an accurate preoperative diagnosis and the necessity of applying the correct surgical procedure to each individual case, in order to reach a sound prognosis and to obtain a permanent cure.

The purpose of this communication is, therefore, to report a series of 29 cases of prostatolithiasis that have come under my personal observation and to discuss briefly this important subject, in the hope of stimulating further studies and research in this field.

Up to the end of the sixteenth century only the most vague ideas existed with reference to prostatic calculi. The first definite reference to the subject is found in the writings of Marcellus Donatus,[11] who, in 1586, reported that he had observed a stone in the prostate of one of his patients which caused an

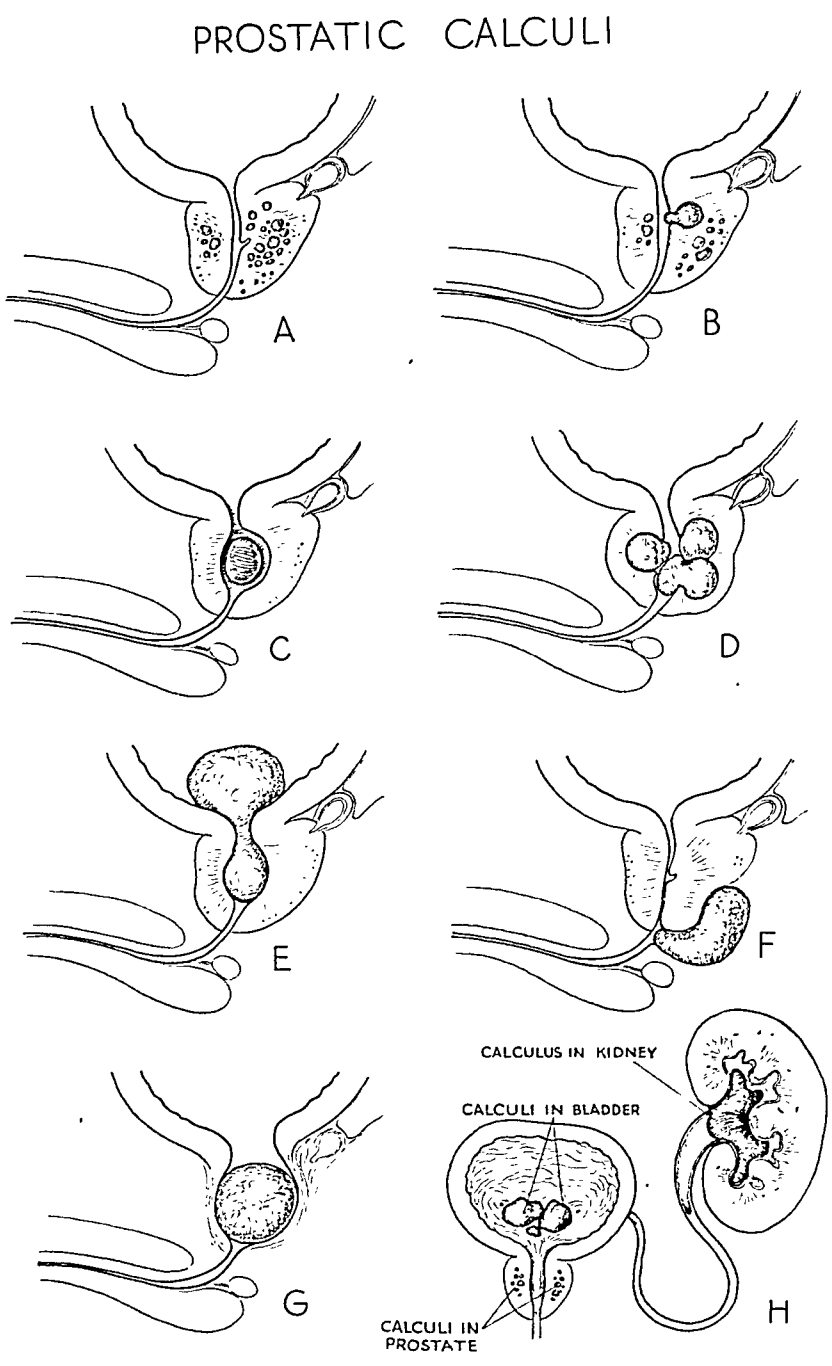


FIG. 1.—Schematic drawing to illustrate the different types of prostatic calculi: (A) Multiple prostatic calculi of endogenous origin within the body of the prostate and having no connection with the urinary tract. (B) Represents the conception of a mixed endo-exogenous calculus within the prostate, in which one of the endogenous calculi has ruptured through the mucosa of the urethra where it meets the exogenous elements of the urine, accelerating its growth. (C) A prostatic stone, coming from the upper urinary tract, has become embedded in the region of the prostatic urethra. (D) Multiple calculi have formed in a diverticulum resulting from the rupture of a prostatic abscess. (E) A prostato-urethrovesical calculus impacted in the vesical neck, producing marked obstruction to the outflow of the urine. (F) A paraprostatic calculus occupying a diverticulum of the membranous urethra at the apex of the prostate, and encroaching upon the gland. (G) Prostatic calculus formed in the region of the prostatic urethra after prostatectomy. (H) Prostatolithiasis associated with vesical calculi and nephrolithiasis.

obstruction to the secretions of the organ. In 1619, Fabricius Bartoletus[3] recorded a case of complete urinary retention in a patient who had a stone "formed by retained sperm," which made pressure upon the neck of the bladder. In 1707, Jacobus Douglas[12] reported the case of an aged man in whom he had found some small, hard, white bodies resembling peas of stony consistency. They presented a polished appearance on their external aspect: "Some of them were situated in the prostate itself, while others were attached by small rootlets to the covering membrane of the gland." In the same year Frederic Lessius[30] wrote of a stone that blocked the canal of the prostate into the urethra, causing sterility.

Not until 30 years later, however, did anything that could be called definite appear on the subject when Pohl,[46] in 1737, gave the first description that was of any real value, in a work entitled, "Prostates affectées d'un calcul," in which he made a serious study of the condition. This was followed by allusions to the subject by Louis,[3] in 1747, in his "Mémoires sur les pierres urinaires," and by Morgagni,[41] in 1762, the latter author giving a description of small prostatic stones that is still regarded as a classic. During the early part of the nineteenth century prostatic stones were discussed by Home,[23] Amussat,[2] and Marcet and Civiale,[7] none of whom, however, appears to have had any very clear ideas on the subject, either with reference to their etiology or to the organic changes to which they may give rise. After Vidal de Cassis[58] and Velpeau[57] had given some study to these calculi, Leroy d'Etiolles[32] reported a number of cases, upon which he operated by a special "urethrolithotritor" devised for the purpose of crushing stones in the prostate. In the latter half of the century several French theses were published, notably those of Bernard[4] (1857), Mélisson[37] (1873), Malteste[34] (1876), and Ménagé[38] (1880). In England, H. Thompson[55] (1861) found space for a chapter on the subject in his treatise on diseases of the urinary tract.

At the close of the nineteenth century, the subject received scientific consideration in the works of Guyon,[20] Albarran,[1] Legueu,[29] and Pasteau,[45] all of whom have discussed at length the pathogenesis and treatment of these calculi. In 1901, the whole subject was reviewed and brought up-to-date in the comprehensive thesis of Tarnaud,[53] which included reports of 51 cases found in the literature. Calculi of the prostate proper (endogenous) and calculi of the prostatic urethra were distinguished, and a detailed study made of their pathologic anatomy, pathogenesis, diagnosis and treatment.

Within the current century, since radiography and, later, urography have become routine methods of examination, the subject has received the attention of many leading urologists. Important contributions have been written by Young,[62] Kretschmer,[28] Judd and Crenshaw,[27] Thomas and Robert,[54] Judd, Parker and Morse,[26] G. J. Thompson,[56] Moore[39, 40] and others; in England the subject has been discussed by Joly,[25] White,[61] and Thomson Walker;[60a] in Germany by Virchow,[59] Englisch,[13] Gläsel,[15] Posner,[46a] and others; and in France by Pasteau,[45] Delauney,[10] Gayet,[14] Oraison,[44] Pousson,[47] and Corlineau.[9]

From time to time, histologic examinations of large series of prostates removed at autopsy have been reported in the literature by various authors, from which it became evident that the presence of prostatic calculi is relatively common. Recently Randall[49] published a monograph on the surgical pathology of prostatic obstructions in which he stated that in routine autopsy specimens of 324 subjects, 86, or 26.5 per cent, were positive for prostatic calculi, which indicates a hitherto unsuspected frequency of this type of pathology.

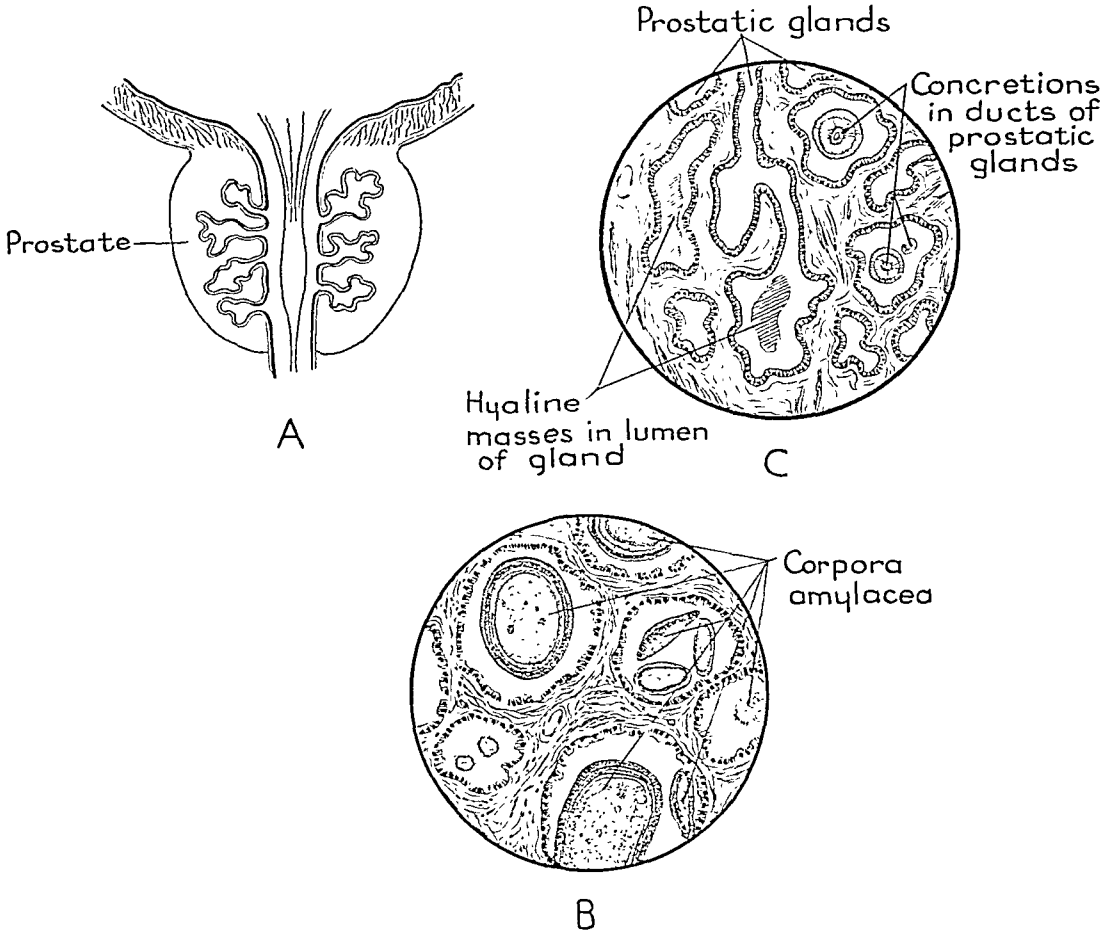


FIG. 2.—Schematic drawing to illustrate the etiology of endogenous prostatic calculi: (A) Transverse section of prostate, showing the racemose structure of the organ. (B) Drawing from a histologic section of the prostate showing the presence of multiple corpora amylacea in the acini of the gland. (High power). (C) Drawing of another section showing hyaline masses in the lumina of the gland and the presence of concretions forming around the corpora amylacea in the prostatic ducts. (Low power.)

Etiology.—In seeking the cause of prostatic calculi, we must recognize two different etiologic types, namely the endogenous or intraprostatic stones, formed wholly within the gland, and the exogenous or urinary calculi, which reach the prostate from various parts of the urinary tract and become lodged within it. The latter are by far the most frequent and are the type that comes, in the main, for surgical treatment because of the obstructive symptoms they produce.

Endogenous Prostatic Calculi.—These have as their nucleus the minute corpora amylacea, which are physiologic within the prostate. These corpora,

consisting of desquamated epithelial cells and of elements found in the prostatic secretion, such as lecithin and albuminoid substances, have been known since the time of Morgagni (1723) and have also been accurately described by Robin,[51] Virchow,[59] and Albarran.[1] Quite recently the subject has been thoroughly discussed by Moore and Hanzel.[40] Moore found them to be already existent in the fetus at seven months, but to be especially abundant in males over 50 years of age, in whom the tall columnar epithelium of youth, less readily desquamated, has gradually given place to epithelium of low cuboid type, more liable to desquamation, which is further encouraged by the passive hyperemia which overtakes the gland in later years. Senile atrophy of the parenchyma, with partial occlusion of the prostatic ducts and stagnation of their contents, seems also to be a factor in their formation. Whenever, from any cause, these corpora amylacea become increased in size and more abundant in number, they tend to act as foreign bodies, exciting inflammation, whereupon salts of lime become deposited upon them, which in time cause formation of calculi (Fig. 2). Calcium phosphate, calcium carbonate and the organic matter within the corpora unite together to form true calculi. This is especially the case when urine has access to them through a dilated prostatic duct, after which their growth is relatively rapid, and may result in abscess formation and ulceration, as a rule in the direction of the urethra. Such stones, however, may be formed in any part of the prostate gland, and may, under some conditions, remain silent for a long time, giving their owner no trouble whatever until they open into the urethra. While these endogenous prostatic calculi may occur at any age, particularly in individuals suffering from chronic prostatitis, they are more commonly observed in the later years of life, and are as a rule associated with infection or adenomatous hypertrophy of the prostate. In fact, in performing a perineal prostatectomy, in which no diagnosis of prostatic calculi has previously been made, it frequently happens that upon incision of the prostate the knife comes in contact with multiple concretions, calcifications or minute seeds of sand or stones, which may be seen macroscopically.

Exogenous Prostatic Calculi.—These have a different etiology. Coming from the upper urinary tract, from which they may have been expelled by an attack of colic, they arrive at length in the prostatic urethra, where their further progress is blocked by the narrowness of the tract, or by the mechanical obstruction offered by the verumontanum. Such a narrowing may be either physiologic or pathologic. In the latter case it may be the result of an old infection within the prostatic urethra, which has left a permanent contracture, making the passage of any but the smallest stones impossible. Under these conditions, the calculus, developing slowly in its new position, may push back the glandular tissue and form a cavity or diverticulum within the prostate, into which it insinuates itself. Being constantly in communication with the urethra, and hence exposed to the action of urinary salts, such a stone will gradually increase in size as it becomes more and more deeply imbedded within the gland. Now and then one of these calculi, thus ensconced within the

prostate, tends to become further enlarged in a retrograde direction, resulting in a prostato-urethral or even a prostato-urethrovesical calculus. Sometimes a stone may thus become impacted within the prostate without urinary retention occurring, since it may be of too small a size to block the urinary flow, or, again, it may have dug out a channel that permits the urine to flow around it and escape normally, through a perfectly patent urethra.

Among common causes giving rise to small diverticula within the prostate, which invite calculus formation, are traumatism of the prostatic region, bungling attempts at catheterization, and the presence of fistulous openings

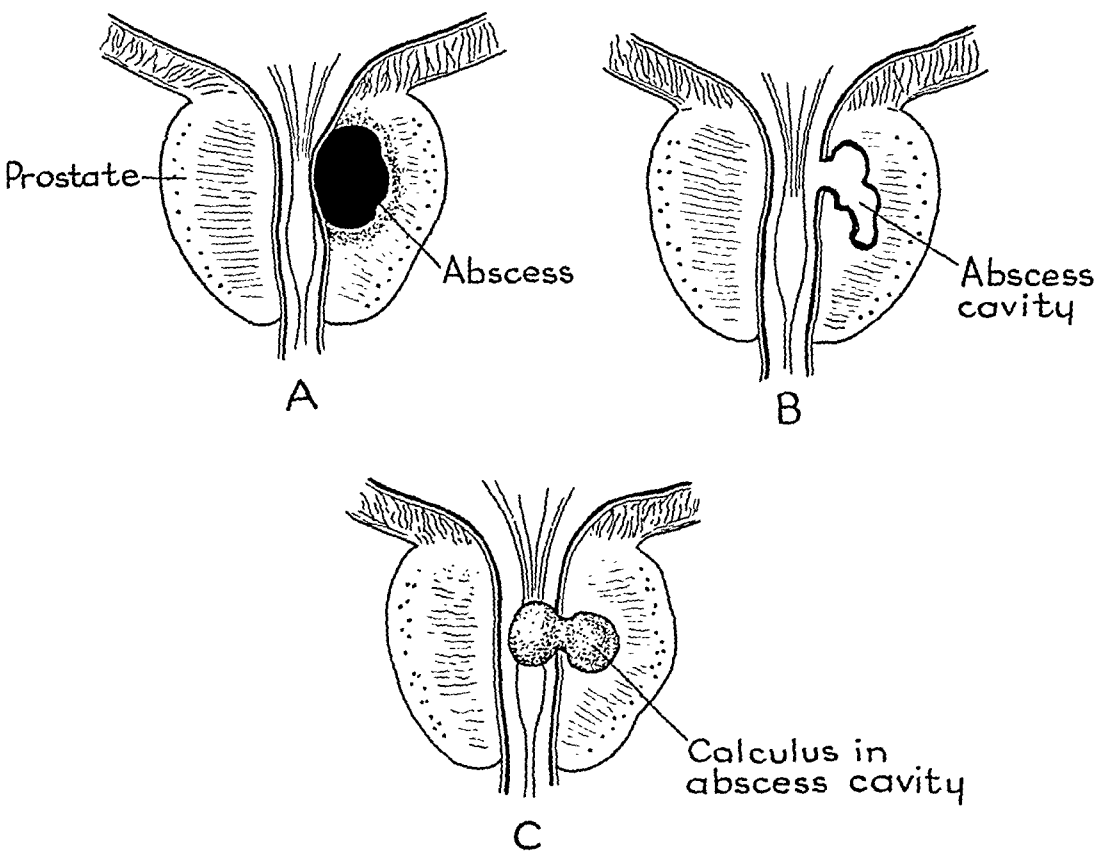


FIG. 3.—Drawing to illustrate the etiology of exogenous prostatic calculi: (A) The prostate with a small prostatic abscess. (B) The cavity of a diverticulum remaining after drainage of the abscess. (C) The prostatic calculus forming within the diverticulum and blocking the lumen of the prostatic urethra.

from prostatic abscesses, the result of long-standing prostatitis (Fig. 3). In addition, the openings of the small glandular orifices or crypts which are the terminations of the prostatic ducts may allow small urinary calculi to become wedged within them, after which such calculi grow like any others exposed to the urinary stream.

All these stones which come from the upper urinary tract while they are still of small size have been termed *migratory*, since they arrive from outside the prostate and take possession secondarily of pockets, diverticula and abscess cavities which have resulted from conditions of infection or traumatism and have ruptured into the prostatic urethra. They then have perfect freedom

either to develop within the prostate or to send branches back into the bladder, building up large calculous masses, sometimes with conspicuous pedicles uniting the prostatic and vesical portions, with the resulting stone resembling a dumbbell or collar-button in its shape. These large stones then become a source of suppuration which may invade large portions of the urinary tract, and may even result in periprostatitis with fistulous openings into the urethra, the rectum, the perineum and even the peritoneal cavity.

Another form of calculus of exogenous type is found in cases in which, after prostatectomy has been performed, a stone develops within the cavity of the remaining capsule of the prostate. Calculi may also be formed after other types of operation, such as external urethrotomies or after operations for drainage of prostatic abscess. Furthermore, we may find instances of *paraprostatic calculi* in which the stone is formed inside a diverticulum of the membranous urethra and closely adherent to the prostate gland, where it has the same surgical significance as the true prostatic calculi (Fig. 1 F).

There is a class of *borderline* cases of endogenous prostatic calculi, in which it is difficult to differentiate, both clinically and anatomopathologically, between endogenous and exogenous calculi. Such a case exists when, because of the racemose structure of the acini of the gland, the multiplicity of the calculi and the large number of ducts opening in the region of the prostatic urethra, a small intraglandular stone finally breaks through the mucosa and opens its way into the lumen of the urethra, constituting what I am inclined to call a mixed endo-exogenous type, because the calculus, although its nucleus originated within the prostate, has beeen brought to the surface of the deep urethra, where it is in contact with the exogenous elements of the urine; these clothe it with layer upon layer of urinary salts, which alter its character, and give it a tendency to grow faster and to become a true prostato-urinary calculus. In some instances several corpora amylacea, or endoprostatic nuclei, have been found combining to form a single stone, covered with exogenous urinary salts. In fact, it is not uncommon to observe in one and the same prostate the two types of calculosis, in which the obstructing symptoms demand surgical relief by removal of the active offending foci.

There is good reason to believe that in addition to the local conditions of lack of drainage, infection, and presence of congenital anomalous pockets in the region of the prostatic urethra, a constitutional factor also plays a part in prostatolithiasis, just as occurs in nephrolithiasis. As a result of this constitutional factor, we may, therefore, observe in the same individual a general urogenital calculosis, expressed in various parts of the urogenital tract (Fig. 1 H).

Pathology.—Whenever a calculus becomes lodged within the prostatic urethra, or within the body of the prostate itself, there will be concomitant infection. Surgical stones are never formed in normal prostates. As a rule, there is a previous history of gonorrhea or some type of urethral discharge which has been present in the patient off and on without his having paid much attention to it. Although in the case of very small intraglandular concretions

the infection may be so slight as to produce no symptoms, nevertheless, routine microscopic examination of the prostatic fluid reveals the presence of many pus cells, indicating that an active focus of infection is present and that the patient is in reality suffering with chronic prostatitis or an infected adenomatous prostatic hypertrophy. In addition many authors have reported the common finding at postmortem of multiple grains of prostatic sand or minute prostatic calculi, visible to the naked eye, in a large percentage of elderly individuals who have died of other diseases.

There is a tendency for this infection to invade the racemose tissue of the prostate and to disseminate through its minute arborizations, resulting in congestion of the organ and appearance of inflammatory attacks within its structure. In time the inflammation produces an abscess of the prostate, with all the symptoms of acute suppurative prostatitis. The abscess may open spontaneously into the urethra, the rectum, or the perineum, but if it fails to evacuate the calculus, a fistula remains and other abscesses may form. Through this fistulous opening urine infiltrates into the recesses of the prostate, causing further complications. A congenital or acquired diverticulum or cyst of the region of the prostate may harbor many hundreds of small faceted prostatic calculi, all sometimes contained in a single pocket. In a study of diverticula of the male urethra, made in 1928, I had occasion to review the literature on the subject, and was able to collect and tabulate 116 cases of this kind. It was interesting to find that in 34 per cent the diverticulum was located in the region of the prostatic urethra, and that in one-half of these cases prostatic calculi were found at the time of perineal operation. When the infection arising from such a collection of stones finds its way into the substance of the gland, extensive abscesses develop with widespread suppuration and breaking down of tissues.

The infection may now pass from the prostate into the entire urinary system, causing the upper urinary tract to react disadvantageously. The bladder is the first organ to feel the brunt of the ascending infection—since prostatic stones are frequently associated with stricture of the prostatic urethra, vesical involvement is a foregone conclusion. The urine becomes cloudy and purulent, and gives off a strong ammoniacal odor. Retention of urine is only a step toward generalization of the infection in the direction of the ureters and kidney pelves. If relief is not obtained by spontaneous evacuation of the calculus, or by operative intervention, a state of general sepsis or a pyelonephritis may result, accompanied by gastric and intestinal disturbances of a grave nature, which in extreme cases may even terminate fatally. More commonly, however, the patient finds relief of symptoms through operation before any such alarming complications set in.

It should always be borne in mind that prostatic stones, like all other calculi, readily act as foci of infection through the blood and lymphatics as well as through the urogenital tract, so that no part of the body is immune from the mischief that they may cause if they remain without proper surgical treatment. At the same time, one should not forget that stones in the prostate,

as a rule, are commonly associated with other pathologic lesions of the urinary tract. In Table I are tabulated the most important lesions associated with prostatolithiasis in this series of cases (Table I).

TABLE I

ASSOCIATED PATHOLOGY IN 29 CASES OF PROSTATIC CALCULI

	No of Cases
Lesions of the Prostate·	
Calculi with adenomatous prostatic hypertrophy	8
Calculi with chronic prostatitis	7
Calculi with prostatic carcinoma	2
Calculi following prostatic abscess	2
Calculi with calcification in seminal vesicles	1
Stone in diverticulum of the prostatic urethra	1
Calculi with calcifications of Cowper's glands	1
Calculi in prostatic urethra after prostatectomy	2
Calculi in prostate without clinical evidence of other lesions	1
Lesions of the Kidney	
Nephrolithiasis with prostatolithiasis	2
Horseshoe kidney with prostatic calculi	1
Nephro-ureterolithiasis with prostatic calculi	1
Hydronephrosis with prostatolithiasis	1
Calcifications in hypernephroma with prostatic calculi	1
Calculous pyonephrosis with prostatolithiasis	1
Lesions of the Bladder.	
Carcinoma of bladder with prostatolithiasis	1
Papilloma of bladder with prostatic calculi	1
Prostatic calculi following litholapaxy	1
Vesical stone with prostatic calculi	1
Bladder diverticulum with prostatic calculi	1
Ureterocele with prostatic calculi	1
Bulbous edema in floor of bladder neck	9
Lesions of the Urethra·	
Stricture of urethra with prostatolithiasis	3
Periurethral abscess with prostatic calculi	2
Urethral stone with prostatic calculi	2
Diverticulum of urethra with prostatolithiasis	1
Hypospadias with prostatolithiasis	1
Miscellaneous Lesions·	
Calcifications in adrenal tumor	1
Arthritis .	5
Syphilis	2

It is obvious that prostatic stones and their concomitant infection also produce disturbances in the genital function, which cannot be relieved until the stone has been surgically removed. In extreme cases the calcareous deposits within the prostate have a tendency to occupy all the multiple acini in the gland and to destroy the entire parenchyma, resulting in complete calcification of the whole organ (Fig. 4). In some other cases lesions of contiguous organs of the genital tract, such as acute seminal vesiculitis and even bilateral orchiepididymitis, are observed as the result of the infection caused by the prostatic calculi.

Symptomatology.—When the stone is formed primarily within the prostate, from the corpora amylacea, it may cause absolutely no symptoms, and may not interfere in the least with the physiologic functions of the gland. Even exogenous calculi, incarcerated within the prostate by wedging in from the

urethra, may long be silent, since it is not uncommon for the urine to find its way around them if they are not too large, or if they are snugly tucked into a diverticulum within the prostate gland, leaving the urethra patent. In cases of this kind the patient may not have the least suspicion that a stone is present,

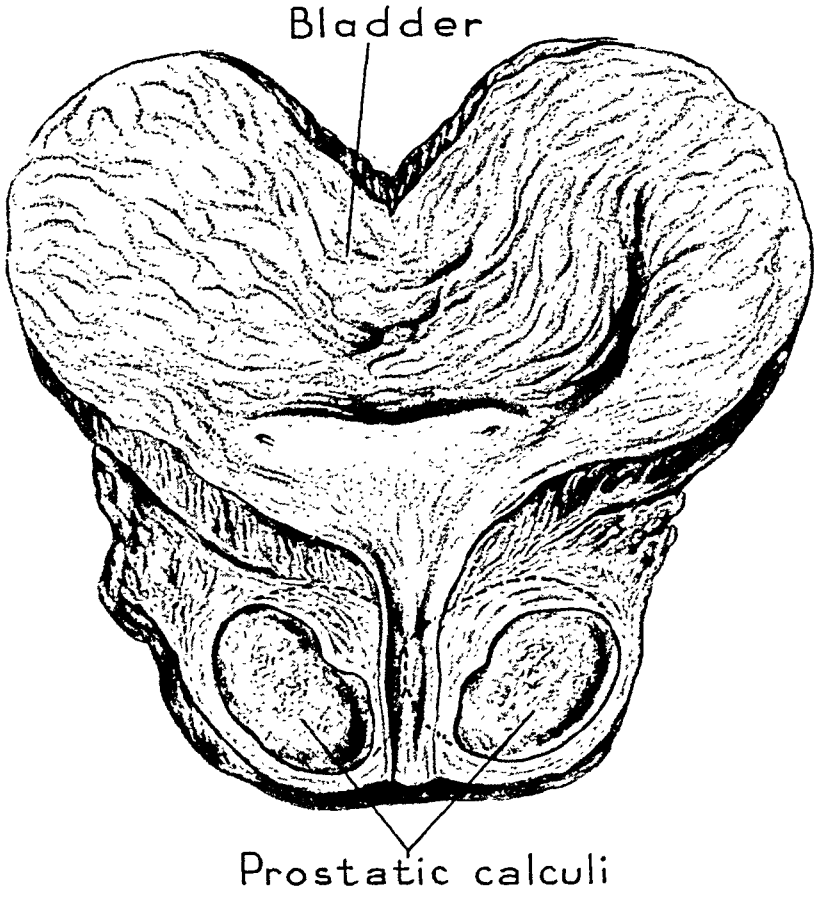


FIG. 4.—Drawing from a postmortem specimen of a completely calcified prostate in a patient 61 years of age who had been suffering with *"urethral stricture"* for more than 10 years (after Randall).

and the true state of affairs may be revealed only when a routine physical examination, including urinalysis, brings to light the presence of a few pus cells and red blood cells in the urine—a finding which demands a digital palpation of the prostate gland and roentgenographic studies. Not infrequently the first symptoms from an endogenous stone appear when such a calculus opens into the urethra or is exposed to contact with the urine. As the stone continues to grow in size from infection and gradual deposit of salts, signs of posterior urethritis or chronic prostatitis appear, which cause the patient to consult an urologist.

When an exogenous calculus becomes engaged in the prostatic urethra, the symptomatology is that of an obstructive prostatic hypertrophy. The stone acts as a foreign body and may cause dysuria and vesical contractions as the urethra attempts to expel it and to clear an outlet for the urinary flow. Pain may be moderate, or it may be violent and excruciating, radiating toward the perineum and anus and along the canal of the urethra, or extending to the

abdomen, groins or thighs. In some cases defecation is difficult and painful. Hematuria may appear, chiefly in an initial or terminal form. Sometimes the bleeding may go inside of the bladder, causing blood clots and total hematuria. In a well-established case, where obstructive symptoms have arrived, the pain is constant, varying from a sense of nagging discomfort to the imperative urgency, and burning and frequency such as are experienced in typical cystitis.

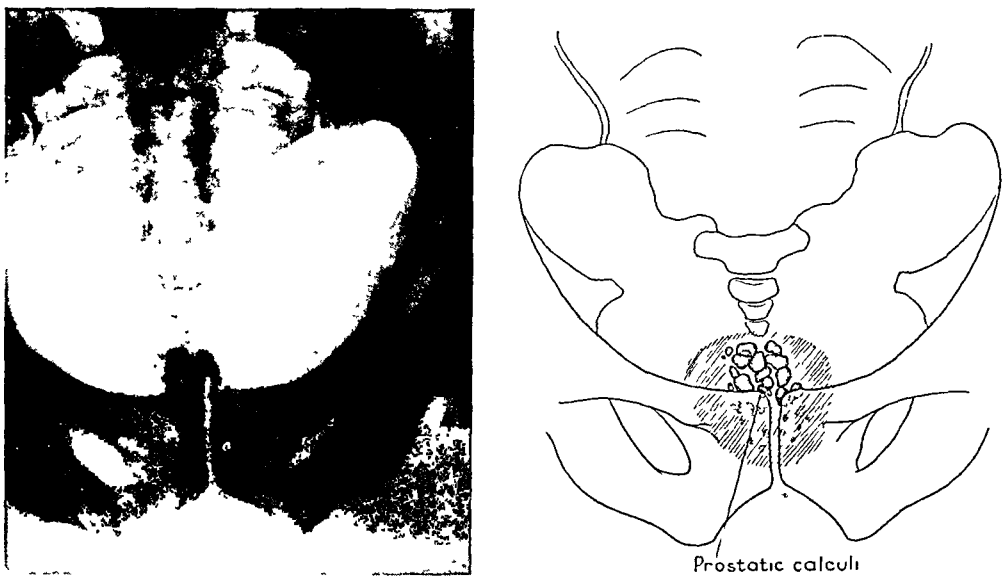


FIG. 5.—Plain roentgenogram revealing the presence of multiple prostatic calculi in Case 29. The accompanying drawing brings out the typical position of the stones in the region of the prostate.

In advanced cases, the general condition will reflect the local distress, and the patient may suffer with all the painful symptoms of an acutely infected prostate and a general toxicity not only of the urinary system but also of the whole body, in some instances manifested in a generalized arthritis. Sometimes the urine contains sand, increasing the difficulty and painfulness of its passage, which may even become impossible. Frequency, dysuria, incontinence, and sudden retention in the midst of urination are all familiar symptoms encountered in cases of prostatic calculi. Stones may be passed, accompanied by the characteristic strangury and colic.

While urinary symptoms are more common than genital, the latter may appear in a certain proportion of cases, in the form of lack of sexual desire, "gleet" or watery urethral discharge and painful and imperfect erections, bloody ejaculation, prickly sensation in the posterior urethra, pain upon ejaculation or impotence. In some cases there is evidence of sterility.

Diagnosis.—The diagnosis of prostatic calculi cannot be made on the basis of the symptoms, since these as a rule show nothing characteristic. In a certain number of cases rectal palpation will give decisive information, and it should be the first recourse if a stone is suspected. Abnormal hardness of the prostate will be suggestive, and it may be that several small, knotty prominences may be felt by the palpating finger. These findings, however,

are still indecisive, until a sensation of fine *crepitation* is elicited, as if stone were rubbing on stone. This sensation is so characteristic and so unmistakable that when it has once been experienced it can never be forgotten—and the diagnosis is plain. When this crepitation occurs, it is indicative of two or

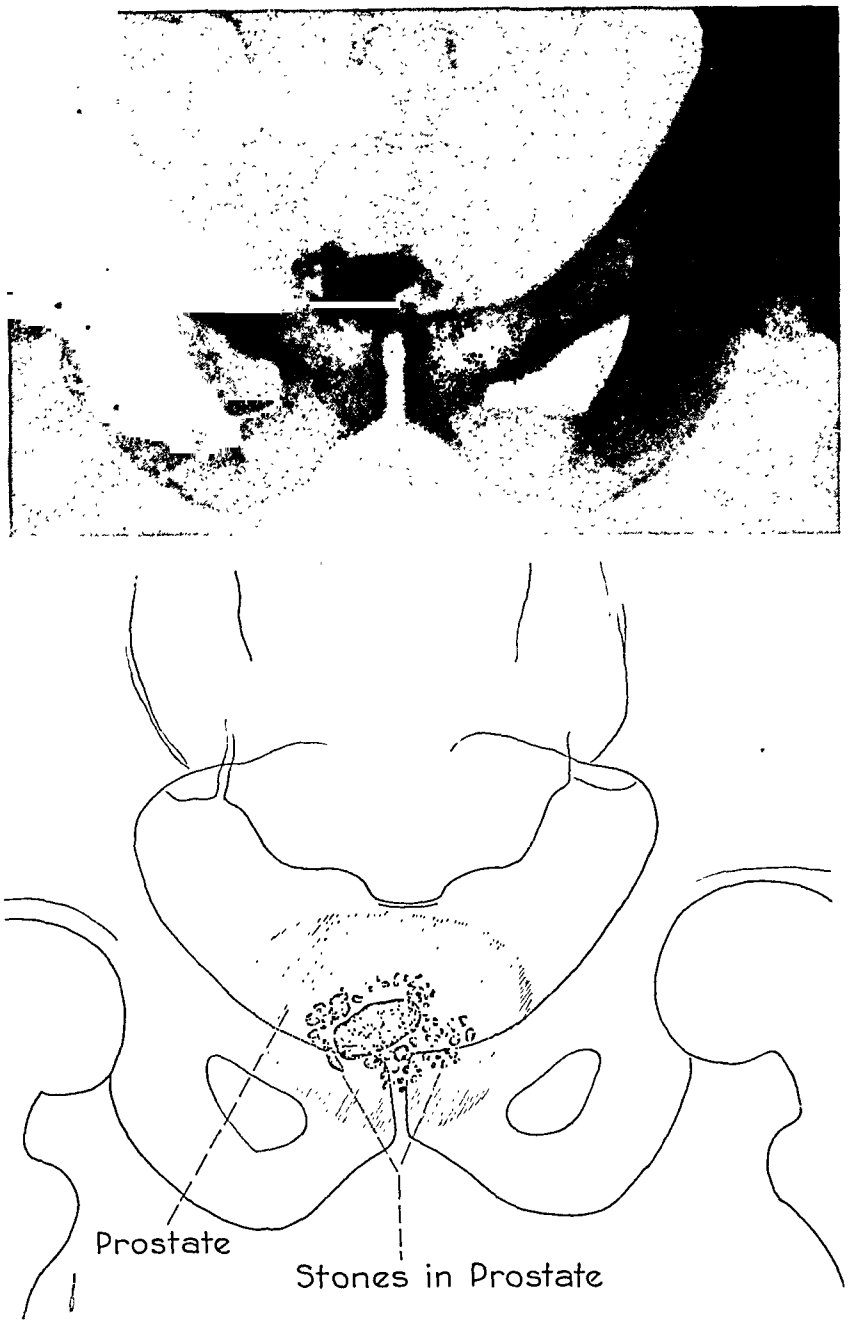


FIG. 6.—Roentgenogram of Case 2: showing the presence of multiple prostatic stones, at the level of the symphysis pubis, in the area of the prostate. The size and position of the calculi are clearly brought out in the drawing.

several small stones within a single pocket within the prostate. It can be obtained from nothing but calculi. If a stone has caused a fistula into the rectum, this too will be recognized by rectal examination. Negative rectal findings, however, will not exclude prostatic calculus.

The location of the stone is of decisive importance for diagnosis. If it is embedded in the middle of the parenchymal portion of the gland it may not be felt upon rectal palpation. However, with a sound placed in the urethra or the cystoscope in position, to make pressure upon the region of the prostatic urethra, and with the finger in the rectum, one may readily feel the calculus, since the tissues in which it lies embedded are thereby made more tense and sensitive as the stone presses upon the urethral sound. In addition, when passing a metal instrument in order to explore the urethra, if the stone is of exogenous type, one can easily hear or feel a click as it scratches upon the metal sound. Although urethral exploration may thus reveal a stone, it is not always clear where it is located, since it may be in the prostate, in Cowper's glands, in a diverticulum of the membranous urethra or in the bladder. Urethroscopy, however, may give a clear view of a small stone or stones projecting through an opening in the region of the prostatic urethra.

Routine cystoscopy and cysto-urethroscopy are also of value because, when the canal is sufficiently patent for the instrument to be passed, they will serve to rule out further pathology in the bladder, such as stone, diverticulum, ureterocele, tumor, *etc.*, and also to visualize accurately the bladder neck, which sometimes gives a typical view of the condition. Moreover, these procedures are of great assistance in determining what type of operation is indicated in each particular case.

The mainstay in the diagnosis, however, is *radiography*. When roentgenograms are properly made they will indicate not only the presence of stones, if such be the case, but also their site, number and size (Fig. 5). In the usual anteroposterior view, if prostatic calculi are in fact present, they will be seen through the shadow of the pubic bone, and protruding above the symphysis pubis, but quite apart from the shadow of the bladder, from which they are separated definitely by a clear space. Even without filling the bladder with an opaque substance, the separation of the prostate from the bladder is clearly recognizable in this position to one familiar with the differentiation (Fig. 6). It is then possible to see whether stones occupy one or both lateral lobes of the prostate; whether they are several or a single stone; and if several, whether these are separate or in groups. Since stone shadows may be superimposed, the exact number of calculi may not be determinable; if the stones are endogenous and small, the image will show a great number of small overlapping shadows in one or two groups separated by a clear space. Another means of differentiation from vesical calculi is given by the size and location; prostatic stones will be in a median position, while a vesical calculus, in order to be median, would have to be of so large a size that it could not be a prostatic stone. In addition to the anteroposterior view, a second film may be made with the rays directed down to the axis of the minor pelvis, in order to avoid the shadow of the pubic bone, which sometimes makes it difficult to visualize small calculi. Shadows of calculi below the symphysis pubis are as a rule stones in a diverticulum of the membranous urethra or Cowper's glands.

Intravenous urograms should be routinely taken, not only to rule out stones

of the upper urinary tract or other pathology of that region, but also to study the topographic relationships of the prostatic calculi in the cystogram. Cystourethrograms should also be made in order to visualize the urethral canal and

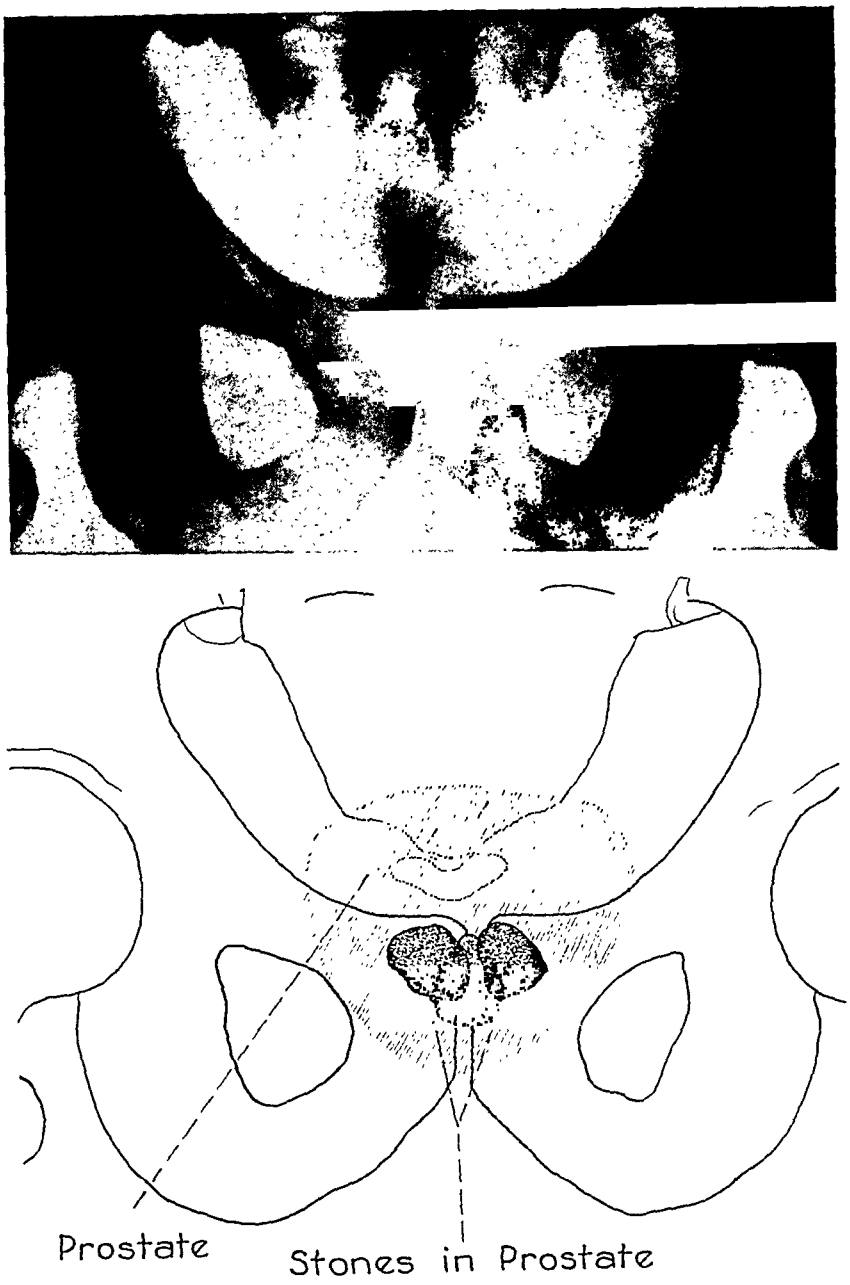


FIG. 7.—Roentgenogram illustrating multiple prostatic calculi in a patient 47 years of age, who had been suffering from acute urinary and genital symptoms for several years, and in whom rectal palpation elicited the characteristic crepitation of prostatic calculi. The accompany drawing brings out clearly the position of the calculi. This patient was cured by perineal prostatolithotomy.

to determine accurately not only the position of the prostatic calculus but also to reveal any other concomitant or associated lesions of the region of the prostatic urethra, and, particularly, to rule out prostatic cavities or diverticula, which are so commonly observed.

Differential Diagnosis.—In the differential diagnosis of prostatic calculi, it is important to bear in mind that stone in the prostate may be simultaneously associated with many other clinical conditions from which it must be distinguished. The most common of these clinicopathologic conditions are carcinoma, tuberculosis, chronic prostatitis, adenomatous prostatic hyperplasia, stone or calcification of Cowper's glands, stone of the seminal vesicles, ampulla and vas deferens, or stone in diverticula of the urethra; also multiple minute stones, grains of sand or fine calcareous deposits, casting no shadow in the roentgenogram, and negative to rectal palpation, but discovered during the course of performing a perineal prostatectomy or in sections made in the specimen removed at postmortem. Calcified lymph nodes or phleboliths may also sometimes confuse the roentgenographic picture. Finally, one should not forget that a stone may form in the cavity remaining after prostatectomy, instances of which have been observed in two of my cases.

Since the symptomatology of prostatolithiasis is misleading, no effort should be spared by the urologist and the roentgenologist whenever urographic studies are to be made, *to include the symphysis pubis or area of the prostate in every film.* When he least expects it, the urologist may discover the presence of prostatic calculi which might otherwise never have been diagnosed.

Surgical Management.—Since the treatment of prostatic calculi depends entirely on the merits of the individual case, all types of calculi of the region of the prostatic urethra have been here considered, from the point of view of their surgical treatment. In cases in which prostatolithiasis is an accidental finding in the roentgenogram or in routine physical examination, and in which the patient has no symptoms related to the condition, it is obvious that no treatment is indicated. However, in this silent group of prostatic calculi, which apparently produce no symptoms, a careful urologic examination may reveal that stones are present and that they are, in fact, a source of infection. Evidence of this will be given by the presence of bacteria in the cultures and of many pus cells in the microscopic examination of the prostatic fluid, as well as by the persistent finding of microscopic pyuria and hematuria in the sediment of the urine. I have more than once seen, in the clinics of various New York hospitals, cases in which prostatic and vesical symptoms had received the routine urologic treatment without relief for more than ten years, but in which the underlying conditions appeared to me to be the presence of multiple prostatic calculi, which were, in fact, discovered upon roentgenographic examination. I believe that many cases of so-called recalcitrant or incurable prostatitis which fail to respond to treatment would prove to be cases of endogenous prostatic calculi, if the diagnosis were accurately made by roentgenographic studies.

When the diagnosis is clear-cut, the treatment will depend on the symptomatology, the age of the patient and the type of associated lesions that may be present. The management of the case should be considered from two different points of view—the urologic and the surgical.

In younger patients with minor urinary or genital symptoms, as a rule

associated with chronic prostatitis, the routine medico-urologic treatment of these cases consisting of massage, instillations, irrigations, dilatations, urinary antiseptics, *etc.*, may produce the spontaneous passage of many small stones, although, as a rule, there will be recurrence through persistence of infection and lack of proper drainage. In the event that these patients fail to improve from this routine treatment it appears that the correct indication is perineal prostatolithotomy. But when the calculi are associated with adenomatous prostatic hypertrophy in an older man, the best indication for relief is perineal prostatectomy.

Meanwhile there are many other urologic and surgical procedures that can be applied for special types of cases. For example, if there is a single stone impacted in the area of the prostatic urethra, this can be removed through a cysto-urethroscope, a procedure which I have carried out in two instances. If the stone is impacted in a dilated prostatic duct and is visible through the cystoscope, the duct can be opened by simple fulguration and the stone pushed back with the electrode or with a catheter into the bladder, from which it can then be removed with the cystoscopic rongeur. If there is a median bar or contracture of the vesical orifice, the ideal method of treatment is transurethral prostatic resection, which will serve to remove the obstructing bar and the stones at the same time. A single stone impacted in the utriculus prostaticus can also be removed endoscopically. But when the stones are multiple, disseminated all through the gland and near the capsule, this procedure is contraindicated, for it is certain that by the transurethral route of approach no one will be able to remove all the calculi present within the gland, and the source of infection and the obstructive symptoms will remain. Furthermore, when multiple stones of the exogenous type are impacted in the region of the prostatic urethra, they cause a narrowing of the canal so that the exploring instrument may fail to pass on account of the obstruction they produce; here, therefore, a perineal prostatolithotomy is obviously indicated. In some cases of prostato-urethrovesical calculi, in which most of the stones are of dumbbell or mushroom shape, and in which the greater portion of the stone is within the bladder, the suprapubic route of approach may find its indication. But it appears that most prostatic calculi, as well as prostatic abscesses, are best treated by surgical removal followed by drainage through the perineum. There is less operative shock, less liability to complications, a shorter stay in the hospital and a better convalescence, with results on the whole more satisfactory.

In the historic background of the surgical treatment of prostatic calculi, several avenues of approach have been used: The perineal, through the median line incision, as in external urethrotomy for stricture, urethral stone, *etc.*; the pararectal incision; the hypogastric or suprapubic; the transurethral for litholapaxy, and the rectal avenue. The rectal route was formerly used by a number of continental surgeons, but this has been entirely given up on account of its many complications, such as fistulae and infection, resulting in a high mortality. In view of the marked progress made along the lines of perineal surgery in the last decades by Albarran,[1] Proust,[48] Young,[62] Hin-



FIG 8.—Urethrocystogram and drawing of Case 14. Showing a small prostatic diverticulum containing calculi, successfully removed by fulguration and endoscopic manipulation.

man[22] and others, the other routes are now seldom used, so that, as a rule, the perineal operation has become the procedure of choice for the removal of prostatic calculi. Even since transurethral resection has become so popular, the perineal route continues to offer indisputable advantages and is superior in the majority of cases.

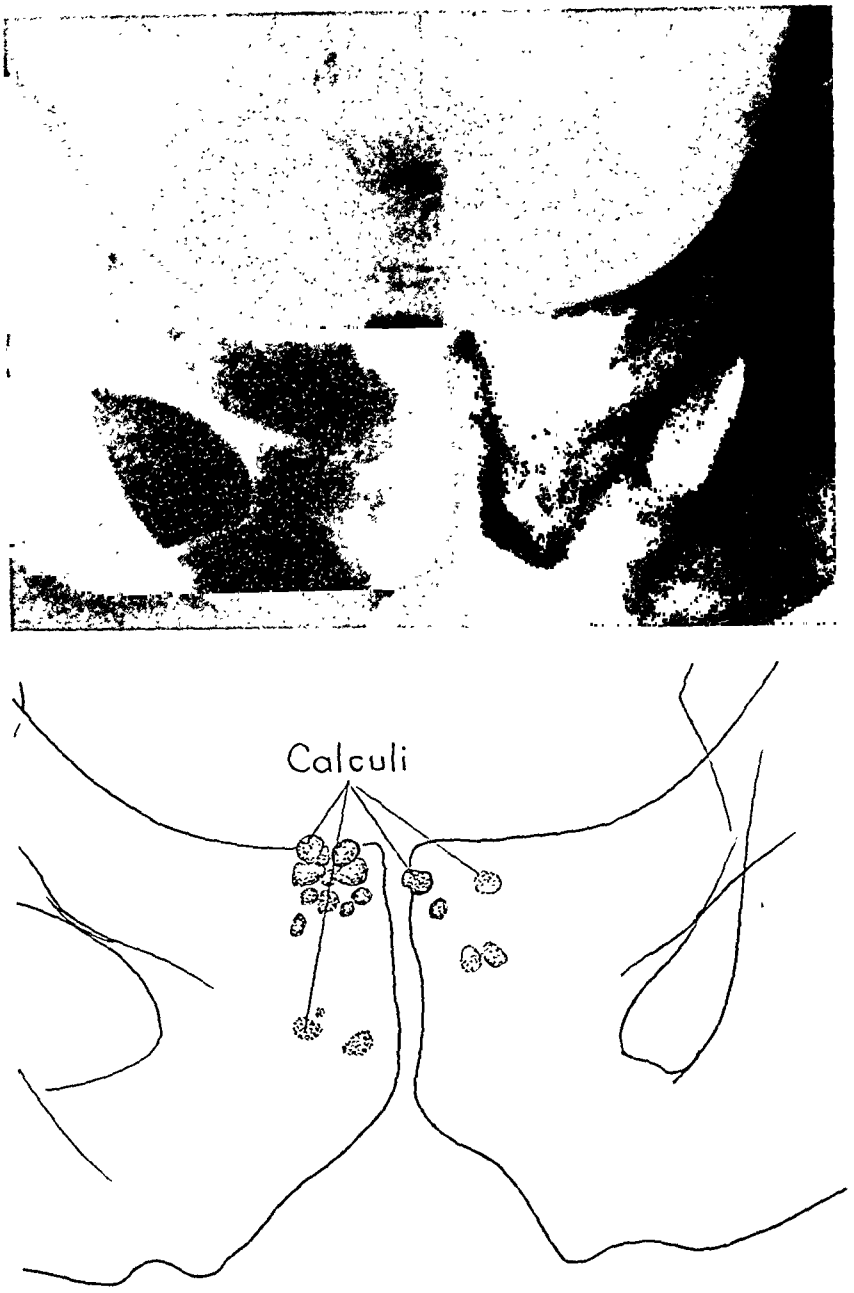


FIG. 9.—Roentgenogram and drawing of Case 20: The patient had suffered from chronic prostatitis and prostatic abscess of long standing. The roentgenogram revealed the presence of multiple prostatic calculi. The patient refused operation and received only conservative medical and urologic treatment.

The open or perineal method secures a complete removal of all the prostatic calculi, many of which would escape detection by the closed or transurethral method, particularly when the calculi are multiple and are associated with prostatitis or adenomatous hypertrophy. It offers a perfect anatomic

exposure, so that the surgeon can follow accurately every step of the entire operation. There are, as a rule, many small stones situated in the plane of cleavage between the adenoma and the prostatic capsule, so deeply situated

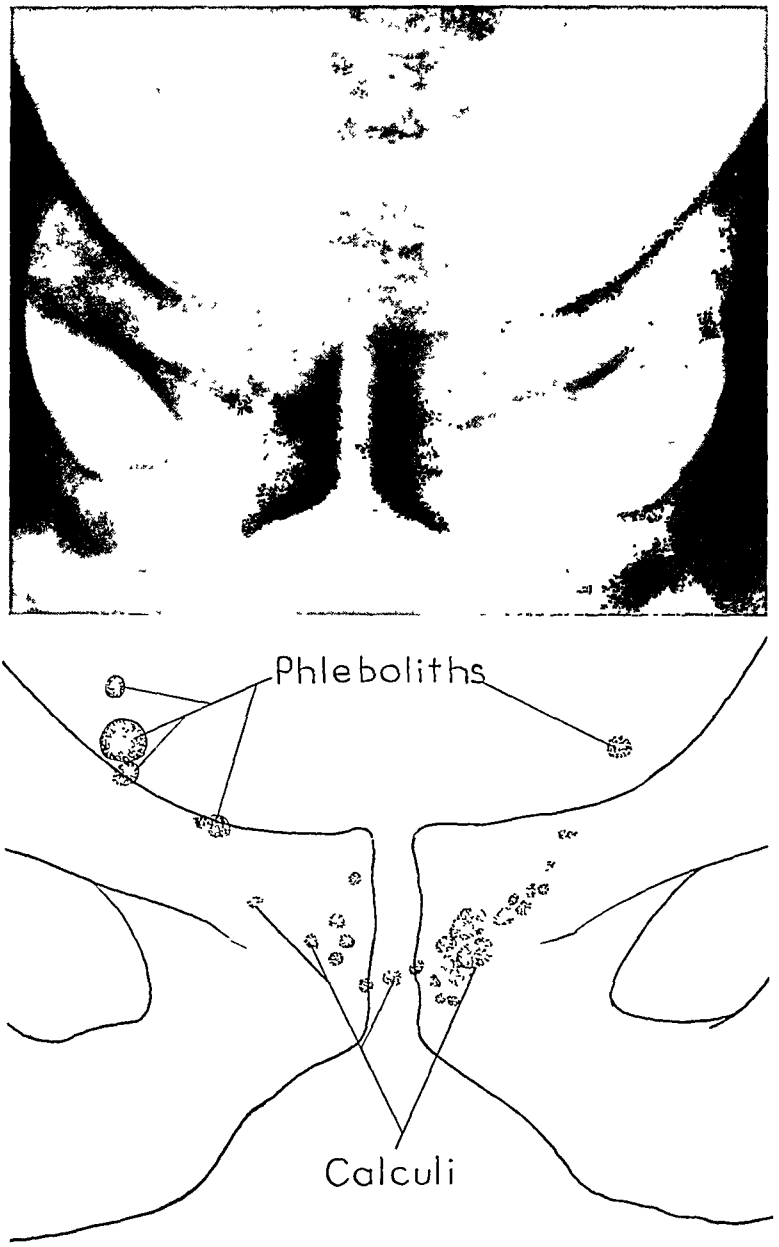


FIG. 10.—Roentgenogram of Case 21: The patient, age 76, had suffered with chronic prostatitis, and had voided small stones on several occasions. Rectal palpation was negative for stones, but the roentgenogram revealed the multiple shadows of calculi in the area of the prostate. The drawing, which has been reversed, indicates the shadows of the calculi and also the presence of phleboliths.

that they cannot be entirely removed either transurethrally or suprapubically. Moreover, in many cases of large-sized stones it is obvious that these cannot be removed from the prostatic bed without considerable trauma, tearing, and



FIG. 11.—Roentgenogram and drawing of Case 6, with cystoscope in place: The patient, age 34, was suffering with acute prostatitis, dysuria and hematuria, in whom the roentgenogram revealed the presence of shadows of small calculi in the area of the prostate. The stones could be plainly felt by rectal palpation.

profuse bleeding, sometimes difficult to control. In addition, it is a well-known fact that most multiple calculi of large size are located in infected pockets, surrounded by a prostatic abscess, and these will be liable to recur and produce sepsis if the cavities are not properly drained to relieve the infection.

Another advantage of the perineal approach is that in certain cases in which stones or calcification exist concomitantly in the ampullae or seminal vesicles, it is possible at the same time to remove these stones through the perineum and provide drainage, as occurs in similar cases of calcification or stones in Cowper's glands or in diverticula of paraprostatic calculi located in the membranous urethra.

In certain cases where a preliminary deviation of the urine by a suprapubic cystostomy is necessary, a two-stage operation may be indicated. Such a case would exist when a traumatic rupture of the membranous or prostatic urethra has left fistulous tracts behind in which prostatic calculi have formed, or when a ruptured prostatic abscess has resulted in perineal or rectal fistulae containing calculi, or in chronic over-distended patients with marked and long-standing suffering from prostatic hypertrophy, in which sepsis, high blood urea, and low renal function demand preliminary drainage and special care in an attempt to have the patient better prepared for the second operation.

Generally speaking, therefore, the ideal surgical procedure for removal of prostatic calculi in well-selected cases appears to be perineal prostatolithotomy, without opening the urinary tract, establishing temporary drainage after operation by merely placing a retention catheter.

Sometimes when the prostatic urethra has to be opened for the removal of the prostatic calculi from the region of the prostatic urethra, there may be two alternatives: one is to drain through the perineum, placing a rubber tube in the bladder as we do in an external urethrotomy or in certain cases of prostatectomy, while the other is to close by interrupted sutures the prostatic capsule and place a self-retaining balloon catheter within the urethra in order to secure good drainage and also to prevent leakage of urine through the perineum.

All these perineal operations on the prostate have been routinely carried out under spinal anesthesia.

Technic of Perineal Prostatolithotomy.—The technic for the perineal exposure of the prostate is essentially the same that has been described elsewhere[18] in the report of more than 200 perineal operations for removal of the prostate and seminal vesicles. After the prostate has been surgically exposed the technic varies from that previously described only in the making of a curved transverse incision upon the surface of the prostate instead of a vertical one, in order to open the prostatic capsule and remove the stones without opening the membranous urethra. This secures a better exposure and allows complete removal of all the calculi, after which, if there is no pus, the capsule is closed with chromic catgut without drainage, placing a retention catheter through the urethra for three or four days in order to put this canal

at rest and secure drainage from the bladder. However, when there is a small pocket of pus present a cigaret drain should be left in one angle of the wound. When the calculi are multiple and are located in the region of the prostatic urethra, it may be necessary to open the latter during the prostatotomy operation. If there is considerable pus, however, it will be better to drain it

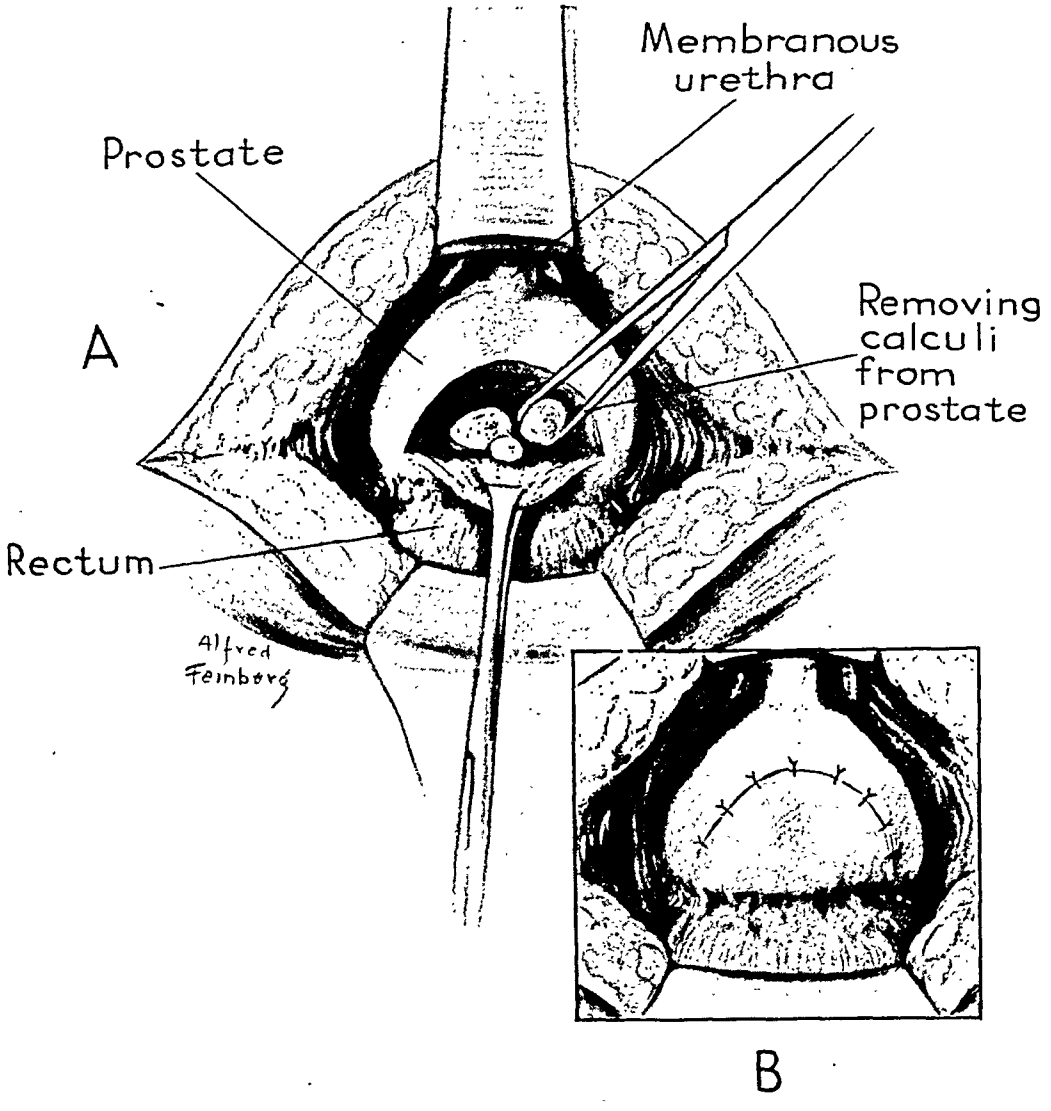


FIG. 12.—Operative technic of perineal prostatolithotomy: (A) The perineal surgical exposure of the prostate, showing a transverse incision on the surface of the gland for the purpose of removing all the calculi that may be present. (B) Method of closure of capsule by interrupted sutures.

perineally by introducing a good-sized catheter through the perineum into the bladder. But if the operation is aseptic and there is a clear-cut exposure of the whole anatomic region, the capsule of the prostate is closed in the usual manner, leaving a cigaret drain in one angle of the perineal wound, and inserting a self-retaining balloon urethral catheter through the urethra into the bladder to serve as an hemostat and to secure perfect drainage, thus facilitating the prompt healing of the wound. As a rule, the cigaret drain is removed 24 to 48 hours after the operation, the retention catheter on the fourth or fifth day, and the stitches on the sixth or seventh day. The patient is al-

lowed to sit out of bed at this time, and to leave the hospital after 12 to 14 days, in the average case, with the perineal wound completly healed.

Perineal Prostatectomy for Removal of Prostatic Calculi.—The common occurrence of prostatolithiasis in association with adenomatous hypertrophy has been clearly recognized in these modern days of accurate urologic investigation. While the main feature of the condition is the obstructive pathology caused by the enlargement of the gland, producing all the urinary symptoms of

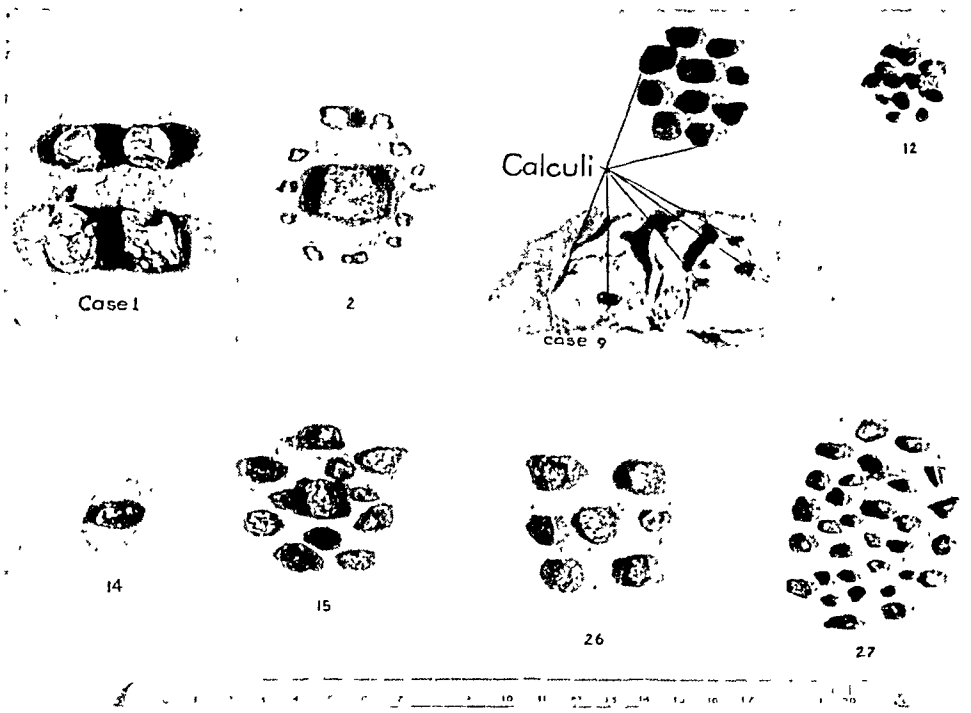


FIG. 13.—Photograph of a collection of prostatic calculi (actual size) removed by the author. The two lateral lobes of the adenomatous prostate removed from Case 9 are shown with multiple calculi impacted within them. Observe, above the organ, another group of prostatic calculi removed from the same case.

prostatism, the multiple, minute, seed-like stones or grains of sand frequently present in the gland are sometimes not revealed until a perineal operation brings them to view. Two groups of cases must, therefore, be kept in mind: one, in which the stone is diagnosed before operation by rectal palpation or by roentgenographic examination of the gland, and the other, in which rectal palpation reveals no concretions or may barely suggest the concomitance of very minute grains of sand, but in which roentgenographic examination shows no evidence of stone shadows because the concretions are composed chiefly of organic substances, which are not opaque to the roentgen ray.

These two groups of prostatolithiasis cases, which are commonly associated with hypertrophy of the gland, come to the urologist for relief of urinary symptoms caused, as a rule, not by the stones but by the obstructive adenomatous pathology. Upon careful urologic examination evidence is found of an infected adenoma, sometimes associated with prostatitis and seminal vesiculitis. This is so much the case that one is accustomed to observe the notable shrink-

age of the gland after cystostomy has been performed as the preliminary drainage in preparation for prostatectomy.

It appears that these two conditions are better handled by an open surgical procedure, in order to remove the entire mass of adenomatous tissue and at the same time the multiple calculi accompanying it. The calculi may be found anywhere within the gland, but as a rule they are most commonly met with beneath the submucosa of the prostatic ducts where these open into the urethra

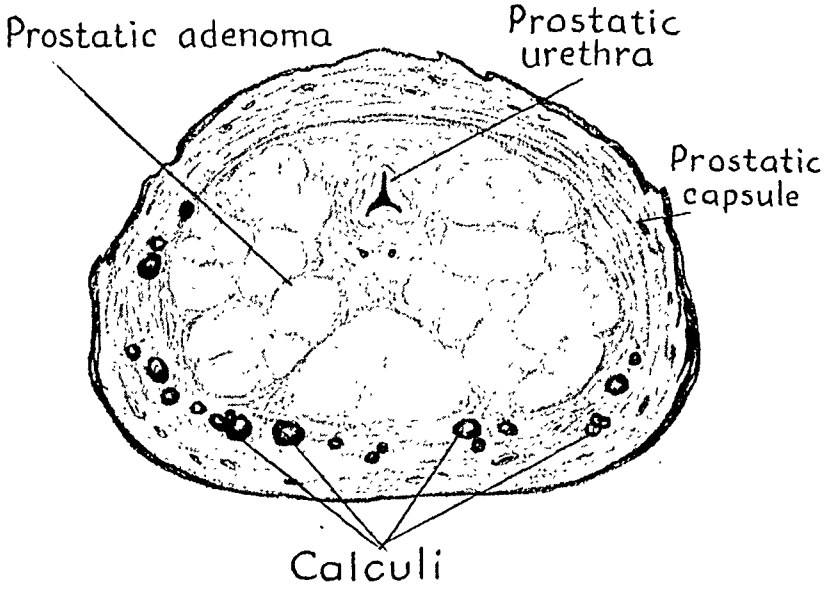


FIG. 14.—Drawing of a cross-section of an adenomatous prostate removed by the perineal route from Case 23: Observe the characteristic location of the prostatic calculi in the plane of cleavage between the adenoma and the capsule, indicating the great advantage of a total perineal prostatectomy over the method of transurethral resection. It is obvious that most of the calculi are situated beyond the reach of the resectoscope.

or in the plane of cleavage of the adenoma, almost in contact with the capsule of the gland, thus demonstrating the superiority of the perineal approach in this type of case (Fig. 14).

Technic of Perineal Prostatectomy for Prostatolithiasis.—In the perineal approach to the prostate, the technic of the first step of the operation is the same as that for perineal prostatolithotomy, except that the transverse curved incision on the posterior aspect of the capsule of the gland is carried deeper in the center, in order to open the floor of the prostatic urethra through which the prostatic retractor is introduced into the bladder. The purpose of the insertion of the retractor is to hold the gland firmly in position and give better exposure. Its complete enucleation can be carried out without opening the membranous urethra. The enucleation is then accomplished by entering the plane of cleavage between the capsule and the adenomatous tissue, which can be easily done by blunt dissection with the index finger; loosening the gland from its attachment and from the floor of the bladder neck, so that the whole specimen of the prostate can be removed in one piece (Fig. 15). During this manipulation many small prostatic calculi can be seen on the surface of the adenomatous gland. After complete hemostasis has been obtained, the bladder

neck is sutured to the membranous urethra, placing a self-retaining balloon catheter in the urethral canal. The edges of the capsule of the prostate are brought together by interrupted sutures, leaving a cigaret drain in the space of the prostatic bed, after which the wound is closed by bringing together the two levator ani muscles as in any other perineal operation. The results from

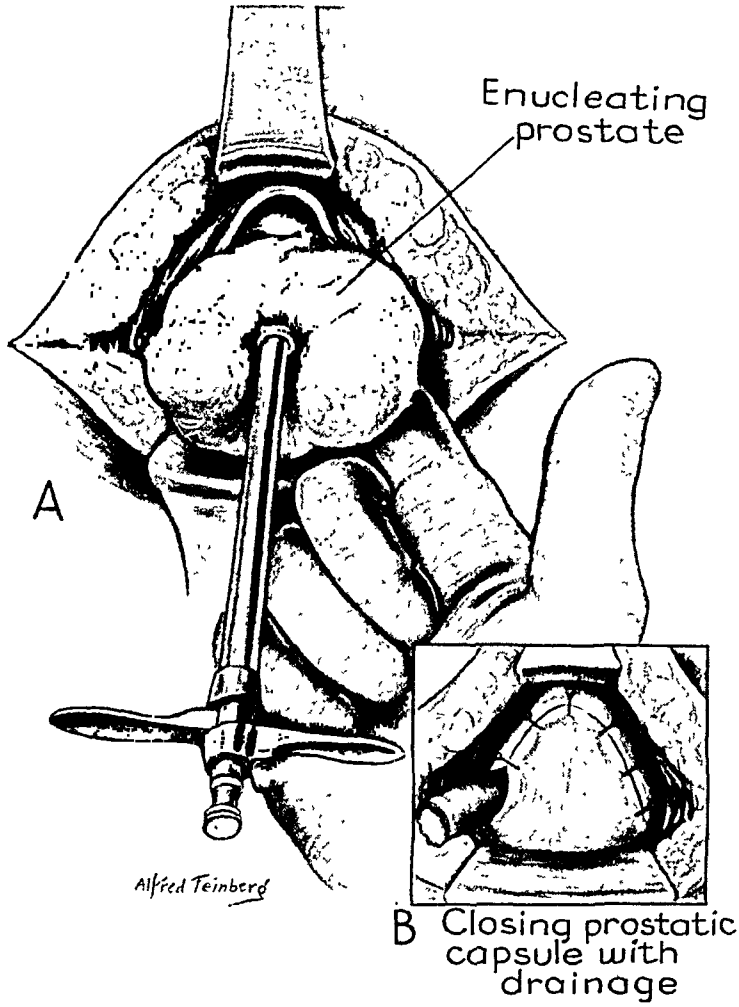


FIG. 15.—Drawing to illustrate the operative technic of perineal prostatectomy, particularly when prostatolithiasis is associated with adenomatous hypertrophy. (A) After the usual perineal surgical exposure, the capsule is opened and a retractor inserted through the prostatic urethra into the bladder, without opening the membranous urethra. The nucleation of the adenoma is then accomplished with the index finger, following the line of cleavage, thus removing the entire organ in one piece. (B) The capsule is closed by interrupted sutures, leaving a cigaret drain in one angle of the wound. (See text.)

use of this technic have been very satisfactory. The cigaret drain, or gauze packing, is removed on the second or third day, the sutures on the sixth day, and the retention catheter after about a week or ten days. With this thoroughly anatomic surgical procedure, a complete removal of the entire adenoma and all the prostatic calculi can be accomplished, effecting permanent cure.

Other Surgical Procedures in Cases of Prostatolithiasis—Associated with

Other Lesions of the Genito-urinary Tract.—It is a common finding that in the presence of prostatolithiasis there may be coexistence of other calculosis elsewhere in the urinary or genital tract, which may demand surgical relief. In other words, prostatic calculus does not exclude calculus in the kidney, ureter, bladder or even in the genital or lower urinary tract; on the contrary, a generalized uroprostatolithiasis is to be expected (Table 1). Cases of this kind should be handled according to the type of pathology they present. In each individual case it must be determined which lesion is the most important and which should, accordingly, be attacked first. In some cases of combined prostatolithiasis and nephrolithiasis, the best clinical results can be obtained by first removing a functionless pyonephrolithiasic kidney, or the stones that are producing pus and destruction in a kidney pelvis, deferring until later the removal of the prostatic calculi, since it is obvious that the pus coming from the upper urinary tract is bound to contaminate the operation upon the lower tract. In certain cases of prostatolithiasis associated with calcifications, concretions or calculi in the seminal vesicles, in which there is evidence of vesicular infection, it may be desirable to perform a combined prostatolithotomy and vesiculolithotomy; in some instances, it may even be wise to carry out a combined and more radical procedure of perineal prostatectomy with seminal vesiculectomy.

Prostatolithiasis Associated with Carcinoma.—The borderline diagnosis of an indurated nodule palpated in the surface of the prostate always suggests the association of malignancy with lithiasis. It must be kept in mind that these two lesions are not infrequently observed together, in which case the differential diagnosis can be accurately made roentgenologically and by a needle biopsy. If there is no evidence of metastasis, or that the malignancy has expanded beyond the capsule, a total radical perineal prostatectomy appears to be the procedure of choice, but when general bony metastasis or carcinosis is obviously present, in association with the stones or calcification in the prostate, it appears that the best treatment is the removal of the obstructing lesion from the vesical orifice by transurethral resection for the purpose of at least relieving the agonizing urinary obstructing symptoms and securing better drainage, while the carcinoma continues its inevitable progress.

Recurrence of Calculi after Prostatectomy.—When the exogenous type of calculus forms again in the prostatic urethra or in the space left behind after suprapubic or perineal prostatectomy, the surgeon must exercise judgment in the choice of the route to be followed. When the stone lodges in the prostatic bed and there is not much infection in the bladder, it can sometimes be removed through cystoscopic manipulations or by simple cystoscopic litholapaxy. In other cases it may be preferable to remove the stone suprapubically. This removal can of course also be carried out by way of the perineum, but it is often much safer to use the suprapubic route for the removal of these large stones, which in most instances extend into the bladder, causing retention and back pressure. Corlineau,[9] in 1932, collected 103 cases of this type from the literature, indicating that the recurrence of calculi is not uncommon following prostatectomy.

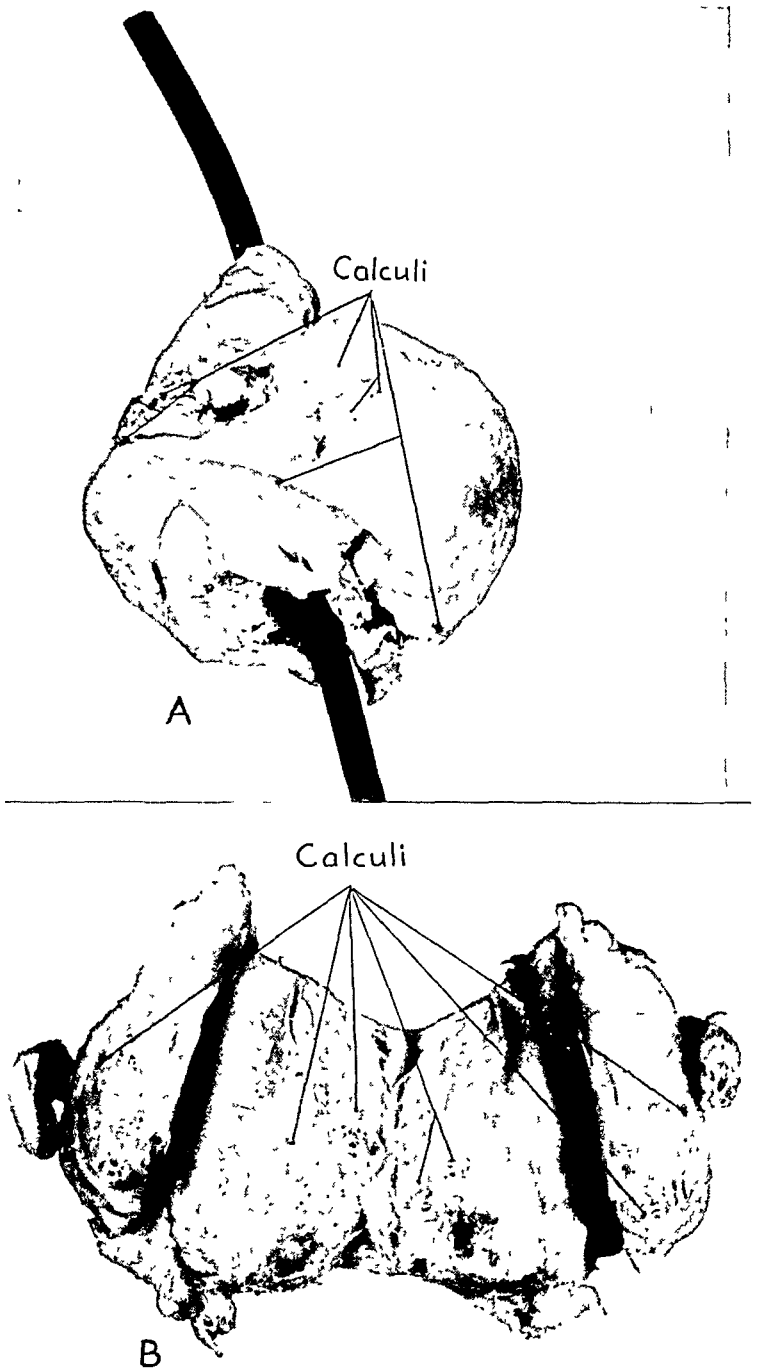


FIG. 16.—Photograph of an enormous adenomatous prostate removed from Case 5, by perineal prostatectomy. (A) The specimen, removed in one piece at operation, is seen mounted on a catheter, and shows multiple minute calculi scattered over the surface of the organ. (B) The same specimen split open, showing the trilobar adenomatous hypertrophy and the presence of innumerable seed-like prostatic calculi, which were an accidental finding at operation.

ILLUSTRATIVE CASE REPORTS

Case 1.—*Perineal prostatotomy for the removal of prostatic calculi:* A. T. E., age 47. Married 15 years. No children. Chief complaint: Frequency, burning, difficult urination, and pain in the perineum for several years. The patient had consulted another physician who had massaged his prostate, given him hot rectal douches and instillations for three years without relief. On September 27, 1934, he consulted my associate, Dr. James Pedersen. Rectal examination disclosed that he was suffering from prostatic calculi. The crepitation of the stones could be felt and almost heard by rectal palpation of the gland. An attempt to explore the urethra and pass a catheter failed, possibly owing to the obstruction caused by one of the stones implanted in the prostate and occupying the lumen of the canal. The voided specimen of urine was cloudy with moderate amount of sediment, containing a heavy amount of albumin, many red blood cells and innumerable pus cells with large clumps.

Operation.—Under spinal anesthesia, with the patient in exaggerated lithotomy position, an attempt to pass a sound through the urethra failed, since one of the stones was blocking the channel of the prostatic urethra. Without instrumental guidance, therefore, a semilunar incision was made in the perineum between the two ischial tuberosities. The central tendon was cut and with further dissection the recto-urethralis muscle was divided and the bulb of the urethra retracted from its attachments. With two lateral retractors the two levator ani muscles were separated, and by further dissection the membranous urethra was exposed at the apex of the prostate. A sound was then passed through the meatus of the urethra so as to allow the passage of the urethral retractor, in order to hold the prostate in position. The layers of Denonvilliers' fascia were incised and stripped back and the posterior surface of the prostatic gland readily exposed. Two vertical incisions were made in the prostate, leaving a bridge of tissue in the middle for the protection of the urethra with its verumontanum and ejaculatory ducts. The index finger was inserted into each side of the prostate and by further manipulation four stones, each about the size of an olive, were removed from the prostate gland. Very little bleeding was encountered. Cigaret drains were placed on both sides of the prostate, and two sutures were placed in each side of the prostatic capsule. The wound was then closed in the usual manner, urethral retractor removed and a soft rubber catheter No. 18 F. was passed into the bladder through the urethra and left in place for drainage. The operation was completed by approximating the two levator ani muscles of the perineum, and closing the floor of the pelvis by a double chromic catgut suture. Interrupted silkworm gut sutures to skin incision.

Postoperative Course.—The patient made an uneventful recovery, and left the hospital with perineal wound nearly healed, 13 days after operation. His general condition gradually improved, and he is free from symptoms at the present time.

COMMENT.—This case illustrates the importance of properly recognizing the multiple prostatic calculi and the good results obtained by an open operation.

Case 2.—*Perineal prostatolithotomy for the removal of multiple prostatic calculi in a case of longstanding so-called incurable urethritis and prostatitis with stricture of the urethra:* R. F. D., age 45. Examined January 14, 1934. The patient stated that he had passed stones since the age of eight, with attacks of chills and fever. Occasional hematuria, pyuria, pain often severe, in right lumbar region and perineum, and in addition generalized rheumatic pains. Married 17 years, no children. No sexual desire and complains of sterility. Had been hospitalized elsewhere on two other occasions. Voided specimen of urine is cloudy and loaded with pus. Rectal examination revealed an enlarged prostate, boggy in consistency, and filled with calculi. Seminal vesicles indefinitely palpable. Miscroscopic examination of prostatic fluid showed more than 100 pus cells per field, with clumps. Both kidneys tender and palpable. External genitals negative, except

that right epididymis was nodular. Exploration of urethra difficult. Residual urine 16 cc. Roentgenologic examination, January 16, 1934, revealed minute, multiple shadows in the area of the prostate and a larger one about the size of an olive in the center. The patient was treated for a while with gentle prostatic massages, sound, bladder irrigations, Kollman dilatation, without complete relief. There was a definite stricture of the urethra, so that catheter No. 18 F. passed with great difficulty; but gradually the canal was dilated to pass No. 24 F. Kollman dilator was also stretched to 29. During these manipulations the patient bled and apparently passed small fragments of calculi. Cystoscopy revealed that the interior of the bladder was normal, but examination of the prostatic urethra showed two definite holes or openings of diverticula in either side and in the middle portion of the prostatic urethra. These prostatic orifices were about the size of a pea and when probed with a bougie appeared to be half an inch deep. The verumontanum appeared to be smaller than normal, but no stone or tumor mass was seen in the lumen of the urethra. It was concluded, therefore, that the prostatic calculi were definitely intraprostatic. The possibility of transurethral prostatic resection was at first considered, but it was decided that there were too many calculi present, disseminated through the gland, many of them almost in contact with the capsule. There was also some fluctuation in the gland on rectal palpation which suggested the concomitance of prostatic abscess with prostatolithiasis. Perineal prostatolithotomy was, therefore, undertaken. This procedure was successfully carried out February 24, 1934, at the Murray Hill Hospital, using the same operative technic as in the previous case, except that a transverse curved incision was made on the prostate, whiclr gave a better surgical exposure for the removal of all the prostatic calculi.

Case 3.—*Small intraprostatic calculi, with no operation:* F. M., age 54. Referred, October 11, 1935, for prostatic treatment. He had slight frequency day and night and sometimes dysuria and a dull pain in perineum. Has been having treatment off and on for prostatitis. Voided specimen of urine clear with shreds. Rectal examination revealed an enlarged prostate three and one-half times its usual size, and of leathery consistency. Between the left side of the midline and the posterior lobe a nodule could be felt, about the size of an olive pit, suggesting the possibility of prostatic calculi. The surrounding tissue was slightly fluctuating, giving the impression that the stone was inside of a small pocket in the posterior lobe of the intraparenchymal portion of the gland. The microscopic examination of the prostatic fluid revealed 20 pus cells per field. Patient has 90 cc. residual urine. *Clinical Diagnosis:* Chronic prostatitis and prostatic calculi.

October 25, 1935: Cystoscopy revealed a slight degree of median lobe prostatic hypertrophy, also slight hypertrophy of the trigone and interureteric ridge, marked bullous edema of the area of the prostatic urethra and vesical orifice, probably due to the presence of prostatic calculi. Roentgenographic studies revealed on either side of the cystoscope a group of small round shadows, suggesting the presence of multiple prostatic calculi. The pyelographic studies showed an associated lesion of right nephroptosis with hydronephrosis. Perineal prostatotomy was advised for removal of the calculi, but patient preferred to have conservative medical treatment. He was, however, cystoscoped and endoscoped on several occasions. The stones in the prostate, felt by rectum, were not seen through the cystoscope, and it was believed that they were situated deep in a lobe of the prostate close to the capsule, where they were without communication with the lumen of the urethra. However, on December 8, 1936, a urethroprostatocystogram was taken which revealed a small diverticulum, possibly a dilated prostatic duct, which appeared to have a connection with some of the prostatic calculi seen in other pictures. As the patient persisted in his refusal to be operated upon, the calculi are still present in the prostate, and he is now suffering from acute arthritis of the right shoulder.

COMMENT.—This case illustrates the persistence of infection harbored in a prostate containing calculi and the complications that may arise from not hav-

ing had an open operation to remove the stones which constitute the focus of infection, from which the arthritis in this patient originated.

Case 4.—*Two-stage perineal prostatectomy in a greatly debilitated patient in whom adenomatous prostatic hypertrophy was associated with complete retention and cardiorenal dysfunction. Prostatic calculi found at operation:* J. C. C., age 63. Examined May 11, 1931. The patient complained of pain across the back and frequency of urination day and night. Has been having treatment for a cardiac lesion. Had gonorrhea 30 years ago, and has suffered, for 20 years, with difficulty of urination. Has recently had two attacks of total hematuria, with innumerable blood clots removed from the bladder. Rectal examination revealed an enlarged, leathery prostate of the adenomatous type. Cystoscoped May 14, 1931: Interior of bladder negative except for evidence of hypertrophy of the median and two lateral lobes. There were also two small cysts on the roof of the vesical orifice with some bullous edema of the floor. After a few days of preliminary catheter drainage, a cystostomy was performed, under local anesthesia. Three weeks later, when the blood chemistry and P.S.P. test were within normal limits, a perineal prostatectomy was carried out in the usual manner, under spinal anesthesia. The prostate removed was of considerable size, and when the capsule was incised it was noticed that multiple small grains of sand or seed-like calculi were present. Patient had an uneventful convalescence and left hospital, three weeks after operation.

COMMENT.—This case illustrates the advantage of a two-stage perineal prostatectomy as a safe procedure in advanced cases of adenomatous prostatic hypertrophy of long standing, when the patient's general condition is so impaired that it demands preliminary preparation to restore cardiorenal function. Cases of this type complicated with prostatic calculi demand suitable drainage preliminary to prostatectomy. Multiple prostatic calculi accidentally found can be removed more easily and more completely by the perineal route than in any other way, since the innumerable minute stones found in the line of cleavage between the adenoma and the prostatic capsule can not be reached properly by any other method of approach.

Case 5.—*Case of silent prostatic calculi, found at operation, in an enormous adenomatous prostate:* A. G. M., age 62. Examined May 15, 1936. The patient was suffering with an attack of complete retention of urine. The retention was relieved by catheter and the distended bladder was found to contain 22 ounces of clear urine. He stated that he had had other attacks of retention on two or three earlier occasions and had been relieved by a soft rubber catheter. He also complained of difficulty and frequency of urination, pain in perineum, chronic constipation and sometimes pain in the suprapubic region. Rectal examination revealed a greatly enlarged adenomatous prostate. A total perineal prostatectomy at the Murray Hill Hospital, under spinal anesthesia. Although the preoperative diagnosis of prostatic calculi was not made and no roentgenograms were taken in this case, multiple stones were readily seen, at the time of the perineal operation, when the prostatic capsule was opened (Fig. 16). This case belongs in that group in which the preoperative diagnosis of prostatic calculi is not made until during or after the operation. The prostatectomy was carried out for the obstructing pathology caused by the enlargement of the prostate. The operative technic employed was as follows:

Total Perineal Prostatectomy.—After the usual preparation, with the patient in the exaggerated lithotomy position, a No. 26 F. sound was passed into the bladder without difficulty. A curved incision was then made in the perineum, running from one ischial tuberosity to the other, at about the level of the medial portion of the perineum. The incision cutting the skin and superficial fascia was deeper at each side of the middle line. Then with the handle of the knife the two ischial fossae were well separated by blunt

dissection. A bifid perineal retractor was placed in position, retracting the lower lip of the perineum and central tendon and recto-urethralis muscle were cut through; the two levator ani muscles were separated and retracted. The remaining fibers of the recto-urethralis muscle were cut with scissors; the bulb was separated from its attachment to the apex of the prostate with a bulb retractor. Denonvilliers' aponeurosis was exposed by blunt dissection. The bifid perineal retractor was then replaced by a perineal retractor. With a good exposure, a transverse curved incision was made on the surface of the prostate, opening the prostatic urethra about one-half inch from the membranous urethra, which, although exposed, was not disturbed, in order to protect the external sphincter. The sound, used as a guide and properly placed in the urethra, was then removed and, while the prostatic urethra was open in its middle portion and held with two pairs of Allis' clamps, Young's prostatic retractor was inserted into the bladder through the prostatic urethra without difficulty. The adenomatous prostate then came readily into view and enucleation with the handle of the knife was begun; inserting the index finger inside of the capsule and all the way around the prostate, which was found to be rather easy, a total, intracapsular prostatectomy was carried out without difficulty. Very little bleeding was encountered; two sutures were placed in each side of the prostatic capsule in an attempt to close this cavity, also to bring the portion of the membranous urethra tightly up to the neck of the bladder and floor of the prostatic bed. A small packing was placed inside of this prostatic space. The wound was closed in the usual manner, beginning with the two levator ani muscles, which were drawn together with double chromatic catgut sutures which closed the floor of the perineum tightly. The skin was closed with interrupted silkworm gut sutures, leaving the packings of gauze fastened to one side of the perineum. A soft, No. 22 F., rubber catheter was passed through the urethra and placed in position for permanent drainage.

COMMENT.—This case illustrates the silent type of multiple minute prostatic calculi accidentally discovered in a case of perineal prostatectomy for adenomatous prostatic hypertrophy. The association of prostatolithiasis and adenomatous hyperplasia, while not suspected preoperatively, is in fact quite a common observation.

Case 15.—*Perineal prostatolithotomy for drainage of prostatic abscess and removal of prostatic calculi:* J. N. S., age 68, complained of frequency, burning, dysuria, bladder tenesmus, and pain in the rectum and perineum. He had had a previous operation for rectal fistula 30 years ago. Rectal examination disclosed an enlarged adenomatous prostate of leathery consistency. There was a definite area of fluctuation in the right lateral lobe. Small nodules of prostatic calculi could be felt by rectal palpation. Cystoscopy revealed bullous edema of floor of bladder neck. Roentgenograms disclosed multiple shadows of calculi in area of prostate. A perineal prostatotomy was performed under spinal anesthesia. When the prostate was exposed, by the usual perineal technic, some induration and fluctuation was noticed on the surface of the gland. A transverse incision was made in the capsule of the prostate and considerable pus evacuated. At the same time, a few prostatic calculi were removed. The prostatic cavity was curetted and packed with iodoform gauze. The patient had an uneventful convalescence and left the hospital three weeks after operation.

COMMENT.—This case illustrates the association of prostatic calculi with the formation of prostatic abscess—which demands the removal of the calculi. It also shows the advantage of perineal surgical drainage in order to obtain a permanent cure.

Case 23.—*Association of prostatic calculi and carcinoma of the prostate:* M. G., age 64, had been suffering with frequency, dysuria, and difficulty in urinating for several

years. There was a history of G.C. on three different occasions. Rectal examination disclosed the prostate to be enlarged, and stony hard in consistency, suggesting carcinoma, and the possibility of small, seed-like prostatic calculi. A hard nodule was felt in the posterior lobe. The seminal vesicles were distended and chronically inflamed. There were six ounces of residual cloudy urine. Cystoscopic examination revealed congestion and swelling of bladder neck with marked bullous edema and distortion of the prostatic urethra. After the preliminary preparation, patient had perineal prostatectomy performed for removal of an adenocarcinoma, in which calcifications and multiple calculi were found. Patient had a fairly good recovery although he had a perineal fistula, which, after dilatation of the urethra, healed entirely. He was discharged in good condition.

COMMENT.—This case illustrates the association of carcinoma of the prostate with the presence of prostatic calculi. It is a type of case which is sometimes difficult to differentiate clinically, but by roentgenography, needle biopsy, and histologic examination of the specimen removed at operation, the diagnosis can be accurately made, as was done in this case.

Case 26.—*Prostatolithiasis associated with nephrolithiasis:* L. C., age 48, complained of a lumbar fistula which had persisted for six months following a nephrolithotomy. He also suffered with frequency, dysuria, pyuria, burning and difficulty in urination. The patient had been operated upon elsewhere for the removal of a stone from the left kidney. Roentgenograms revealed some shadows in the area of left kidney indicative of stone, which may be the cause of the infection and the reason why the lumbar wound refused to heal. Complete work-up shows the left kidney to be functionless and the right kidney to have a good urea and P.S.P. output. Pyelograms also reveal complete destruction of the left kidney, with associated evidence of calculi in the area of the prostate. A left nephrectomy was performed, followed one year later by a perineal prostatolithotomy for the removal of the prostatic calculi. The patient is, at present, well and free from urinary symptoms.

COMMENT.—This case illustrates the advantage of a complete urologic examination in order to establish an accurate preoperative diagnosis. It also shows the wisdom of first removing the nephrolithiasic, functionless kidney, and attacking the prostatolithiasic problem at a later date, in order to obtain a permanent cure.

SUMMARY OF 29 CASES OF PROSTATIC CALCULI

In this series of cases, all the patients were suffering with urinary symptoms, ranging from simple frequency and dysuria to hematuria, tenesmus and complete retention of urine. Genital and rectal symptoms were also quite frequently observed. Most of the patients, however, came to the urologist complaining of a combination of urinary, genital and rectal disturbances.

In some of these cases, the prostatolithiasis was associated with other pathologic conditions within the urinary tract, as noted in Table I. In some instances, in fact, there was evidence of a generalized lithiasic condition affecting various organs of the genito-urinary tract, demanding a complete urologic examination and appropriate surgical treatment.

A summary of the 29 cases is presented in Table II. Here, it can be seen that in some cases it has been necessary to first perform an operation for removal of a functionless nephrolithiasic kidney (Case 26), and then, at a latter

TABLE II

SYNOPSIS OF 29 CASES OF PROSTATIC CALCULI

Case No. Name	Date of Exam.	Age	Symptoms	Clinical Findings	Roentgenologic Diagnosis	Treatment Urologic	Treatment Surgical	Results
1 A. T. E.	10-16-34	47	Frequency, burning, difficulty, pain in perineum. Painful erection. Sterility. Arthritis	Rectal examination elicited crepitation of prostatic calculi. Pus and bloody urine; 100 pus cells in prostatic fluid per H.P.F.	Multiple prostatic calculi	Prostatic massage. Bladder lavage. Hot rectal douches	Perineal prostatolithotomy	Cured
2 R. F. D.	1-16-34	45	Hematuria, pyuria, pain in perineum, generalized arthritis. Painful erections, and ejaculations. History of sterility. Passing stones since the age of eight	Prostate full of stones; marked crepitation. 100 pus cells in prostatic fluid per H.P.F. Stricture of urethra	Shadows of multiple calculi in the area of the prostate	Prostatic massage; sounds; bladder lavage; deep instillations	Perineal prostatolithotomy	Cured
3 F. M.	10-11-35	54	Frequency day and night, dysuria, dullness in perineum and rectum. Anemia. Rheumatoid arthritis	Urine clear, with shreds. Enlarged prostate with calculi in intraprostatic portion of posterior lobe. 20 pus cells per H.P.F.	Small prostatic calculi with associated right nephroptosis and hydronephrosis	Cystoscopy with dilatation of ureters and kidney pelvis lavage. Prostatic massage; deep instillations; sounds, *etc.*	Refused operation	Still suffering from arthritis and minor urinary symptoms
4 E. J. C.	5-11-31	63	Pain across back. Frequency, nocturia, difficulty, pain in perineum and on defecation. Recently had two attacks of hematuria and has a cardiac condition	Rectal examination disclosed adenomatous prostatic hypertrophy	No shadow of stone. Minute calculi found at time of operation	Cystoscopy. Bladder lavage. Indwelling catheter	Two-stage perineal prostatectomy. Recurrence of of stone; removed by cystoscopic litholapaxy	Recurrence of symptoms, with stone in prostatic urethra two years later. Cured after second operation
5 A. E. M.	5-15-36	62	Complete retention of urine. Has had two or three previous attacks. Difficulty, frequency, day and night. Pain in rectum and bladder region	Retention 22 oz. Bladder distended to umbilicus. Adenomatous prostatic hypertrophy. Stone not felt	Calculi found at operation	Retention catheter inserted	Total perineal prostatectomy for removal of adenomatous prostatic hypertrophy; with calculi found at operation	Cured

6 A. B.	10- 8-35	34	Hematuria, marked frequency day and night, dysuria, pyuria, pain in perineum. At times chills and fever. Acute prostatitis and urethritis.	Enlarged and chronically inflamed prostate full of stones. Residual urine 2 oz.	Multiple shadows of prostatic calculi	Cystoscopy. Intravenous urograms. Urethrocystogram	Refused operation	Advised prostatolithotomy. Patient never came back
7 E. C.	4- 6-34	34	Several types of gonorrhea with persistent urethral discharge. Stricture of the urethra. Dysuria, dribbling, Wass. 4†	Enlarged prostate chronically inflamed. 20 pus cells per H.P.F. in prostatic fluid. Positive cultures. Evidence of chronic prostatitis and seminal vesiculitis	Small shadows of prostatic calculi. Right hydronephrosis. Stricture of right ureter. Pyelitis and pyelonephritis	Cystoscopic dilatation of ureters. Kidney pelvis lavage. Prostatic massage. Sounds. Bladder lavage	None	Improved
8 E. G.	12-11-28	41	Frequency, microscopic pyuria, hematuria, pain in left lumbar region and perineum. Impotence	Operated elsewhere for kidney stone ten years ago. Chronic prostatitis with calculi	Calculus in left kidney and multiple shadows of calculi in prostate	None	None	Patient left before treatment was instituted
9 D. M. S.	5- 4-39	57	Pain in right and left lumbar regions. Nocturia, frequency, pain in perineum, urgency, difficulty, dysuria, change in urinary stream. Retention	Adenomatous prostatic hypertrophy with minute prostatic calculi felt by rectum. Pos. cultures. 50 pus cells per H.P.F. Residual 4 oz.	Multiple faint shadows of prostatic calculi. Excretory cystogram revealed considerable residual after urination	Cetheter drainage. Massage. Instillations. Sounds and bladder lavage	Perineal prostatectomy for removal of adenomatous gland and multiple calculi	Cured
10 M. V. A.	3-19-35	61	Frequency, burning, rectal symptoms. Prostoscopy negative. Passed bits of gravel, small green stones and concretions on several occasions. Hematuria, pyuria. Positive culture. Bilateral orchiepididymitis. Retention	Enlarged and boggy prostate by rectum. Difficult catheterization due to stricture of deep urethra. Unable to urinate. At times chills and fever. Prostatic abscess	Multiple seed-like prostatic calculi seen	Drainage of prostatic abscess through urethra by prostatic massage. Sounds, catheters and bladder lavage	Perineal prostatotomy	Cured

TABLE II (*Continued*)

Case No. Name	Date of Exam.	Age	Symptoms	Clinical Findings	Roentgenologic Diagnosis	Treatment Urologic	Treatment Surgical	Results
11 S. B.	11-28-31	60	Hematuria, pyuria, frequency, burning and difficulty. Bladder tenesmus, dysuria and pain in perineum	Enlarged boggy prostate 3 oz. residual cloudy urine. Cystoscopy revealed tumor in diverticulum of urinary bladder	Cystogram revealed retentive type of diverticulum. Filling defect shows presence of bladder tumor. Minute, faint shadows of calculi in area of prostate	Bladder lavages, sounds and prostatic instillations	Partial cystectomy to remove diverticulum containing malignant tumor	Good, for 1 year, from bladder operation. No operation for prostatic calculi. Symptoms persisted but patient left town
12 L. D.	2-27-32	62	Frequency day and night with burning. Pain in rectum and perineum. Prostatic and urinary symptoms for seven years	Prostate enlarged, boggy and leathery, suggesting adenoma and minute seeds of calculi. 40 pus cells per H.P.F. B.P. 170/100. Residual 2½ oz.	Very faint and minute shadows of stones in area of prostate. Cystourethrograms revealed no diverticulum	Bullous edema in prostatic urethra seen at cystoscopy. Multiple cysts at vesical orifice. Contracted vesical neck and median bar	Small stones removed by endoscopic prostatic resection	Improved. Two years later fulguration of cysts of vesical orifice. Still has ½ oz. residual and minor urinary symptoms
13 M. T. M.	4-15-37	56	Frequency day and night, dysuria, difficulty. Urethral discharge on defecation. History of sterility. Heart and prostatic trouble for ten years	Prostate enlarged, boggy, chronically inflamed, adenomatous and full of sand. Residual ½ oz.	Minute, multiple prostatic calculi	Prostatic massage. Deep instillations. Bladder lavage. Sounds and urinary antiseptics	Suprapubic prostatectomy	Cured
14 G. D. P.	12-15-34	30	"Morning drop discharge," dysuria, pyuria and dribbling	Chronic prostatitis. Seminal vesiculitis. 40 pus cells by H.P.F. Urethral stricture	Prostatic calculi. Urethrocystogram revealed prostatic diverticulum with small stone	Prostatic massage. Bladder lavage. Sounds. Kollman dilatation. Deep instillations	Cystoscopic fulguration with removal of stone	Cured
15 J. W. S.	11-18-31	68	Frequency, urgency, burning, dysuria, pyuria, hematuria, pain in perineum. Had operation 30 years ago for rectal fistula. At times severe cystitis with chills and fever. Bladder tenesmus	Prostate enlarged' leathery, adenomatous in type, with small nodule and fluctuation in right lobe. 50 pus cells by H.P.F. Residual urine ½ oz.	Multiple small shadows of calcareous deposits in prostatic area	Bladder lavage. Instillations. Rest in bed. Hot rectal douches. Cathartics. Urinary antiseptics	Prostatolithotomy for removal of calculi and drainage of prostatic abscess	Cured

16 D. S.	7- 1-30	46	Frequency day and night, hesitancy and dribbling. Luetic and G.C. history. Persistent urethral discharge. Treatment for prostatitis for many years without cure. Weak sexual power. Difficult erections	Enlarged prostate, boggy, inflamed. Innumerable small concretions of sand felt. 40 pus cells by H.P.F. with clumps. Calcification in the corpus spongiosum of the glans penis	Multiple faint shadows of calculi in the area of the prostate and shadows of calcification in median portion of glans penis	Cystoscopy and urethrocystoscopy negative, except for chronic verumontanitis, inflammation and a few dilated prostatic ducts. Massage, instillations, sounds, dilatations and urinary antiseptics	None	Improved
17 P. L.	6-26-30	37	"Morning drop discharge." Having treatments for G.C. for several years. Has had bilateral orchiepididymitis. Diminished sexual desire. Impotence	Prostate enlarged four times, boggy, inflamed. 50 pus cells per H.P.F. Prostatic calculi not palpable. Chronic prostatitis, and seminal vesiculitis. Bilateral chronic vasitis and small nodule in both epididymites	Multiple, very faint and small shadows of grains of prostatic calculi seen	Has had fulguration of verumontanum elsewhere on two occasions. Prostatic massage. Instillation, Kollman dilatation. Bladder lavage, sounds, urinary antiseptics, *etc.*	None	Improved
18 C. W.	1- 5-36	68	Frequency day and night with marked urgency. Dysuria and difficulty. Pain in rectum, perineum and suprapubic region. Patient admitted with complete retention	*Enlargement* of the prostate with adenoma and sensation of calcification felt by rectal palpation. 36 oz. residual	Small round shadows of calcification in prostatic region	Cystoscopy revealed trilobar adenomatous hypertrophy	Transurethral prostatic resection, 1-10-36. Patient unable to void. Second resection, 1-23-36; about 100 pieces of tissue removed	Good
19 A. D. S.	11-26-35	65	Hematuria, pain in left kidney region, frequency, dysuria, pyuria, burning difficulty. Cystoscopic fulguration of papilloma of bladder neck on two different occasions elsewhere	Rectal palpation suggests small prostatic calculi. Chronically inflamed prostate and seminal vesicles. Tumor mass easily palpable on left side of abdomen	Calcifications in area of left kidney. Evidence of seed-like calculi in region of prostate. Pyelography disclosed left, large-sized renal tumor	Cystoscopy revealed marked bullous edema of vesical orifice. Deep x-ray to inoperable left kidney tumor	None	Unimproved

TABLE II (*Continued*)

Case No. Name	Date of Exam.	Age	Symptoms	Clinical Findings	Roentgenologic Diagnosis	Urologic	Treatment Surgical	Results
20 G. V. K.	7-12-34	60	Frequency with marked dysuria, hesitancy, difficulty, pain in rectum and perineum. Has had prostatic treatment for 20 years without cure	Prostate enlarged and boggy by rectum. Urine loaded with red blood cells and innumerable leukocytes, with clumps. Culture on different occasions shows streptococcus, colon bacillus and staphylococcus	Racemose shadows at the symphysis pubis revealing the presence of multiple prostatic calculi	Cystoscopy revealed bullous edema at floor of vesical orifice. Endoscopic application to posterior urethra. Massage, instillations, bladder lavage. Hot rectal douche. Urinary antiseptics	Refused operation	Fair
21 E. V. F.	5-29-34	76	Frequency day and night. Hazy urine with calcareous deposits and grains of sand voided in the urine on several occasions	Prostate soft in consistency. No stones felt. Cystoscopy revealed much congestion of prostatic urethra with bullous edema at floor of vesical orifice. Occasional leukocytes and red blood cells in urine	Multiple round shadows of prostatic calculi at level of symphysis pubis	Endoscopic applications to deep urethra. Massage, instillations, sounds, bladder lavage	None	Improved
22 F. C.	10-12-38	53	Hematuria, chills and fever, starting in 1908. In 1920, diagnosed bilateral nephrolithiasis. During 1937-1938, profuse hematuria with lumbar pain. High temperature and loss of weight. Received several blood transfusions elsewhere. Frequency, burning, dysuria, pain in perineum	Prostate enlarged, boggy in consistency, containing small calculi by rectal palpation	Bilateral nephrolithiasis in which both kidney pelves are filled with coraliform calculi. Also bilateral ureterolithiasis with good-sized stones in lower portion of both ureters. Evidence of prostatic calculi	Treatment has been medical with urinary antiseptics, blood transfusions, *etc.* No urologic work done	None	Unimproved

23 M. G.	1- 9-33	64	Frequency, dysuria, nocturia, difficulty, pain in perineum, chronic constipation. Pain on defecation with watery urethral discharge. Has had G.C. on three occasions	6 oz. residual, cloudy urine. Prostate enlarged, firm and stony in consistency, suggests Ca. and small calcareous deposits in each lateral lobe	Small areas of round shadows of calculi in region of prostate	Cystoscopy revealed congested and swollen bladder neck. Definite hypertrophy of lateral lobes with edema of floor of bladder neck	Perineal prostatectomy for removal of prostatic Ca. and calculi	Cured of calculi for one year
24 H. C.	8-10-35	62	Dysuria, frequency, burning, bladder tenesmus and pyuria	Few tags of infected hemorrhoids present. 4½ oz. residual. Prostate enlarged four times the usual size, adenomatous in type, with hard nodule in posterior lobe, suggesting Ca. Both seminal vesicles distended, and chronically inflamed	Many small shadows of calculi in the area of prostate	Cystoscopy revealed hypertrophy of median lobe with minor hypertrophy of the two lateral lobes	Endoscopic prostatic resection	Improved. Lost sight of after two years
25 E. F.	3-10-37	74	Pain in right lumbar region. Frequency day and night. Pain in rectum and perineum	Small hemorrhoids. Prostate enlarged 1½ times, leathery in consistency. Very small grains of sand or calculi felt. Bilateral hydrocele. Residual 2 oz.	Pyelograms revealed right renal tumor. X-ray disclosed shadows of prostatic calculi in the region of symphysis pubis	Cystoscopy showed slight congestion and bullous edema of floor of bladder neck. Deep x-ray to renal tumor	None	Unimproved
26 L. C.	1- 5-37	48	Lumbar sinus eight months after left nephrolithotomy. Frequency, dysuria, pyuria, burning and difficulty. Loss of weight and anemia	Urine is cloudy, contains pus. Prostate enlarged, leathery in consistency, with evidence of small calculi	Left nephrolithiasis with functionless pyonephrotic kidney. Also evidence of small shadows of calculi in area of prostate	Cystoscopy revealed much bullous edema in floor of bladder neck and prostatic urethra	Left nephrectomy. Perineal prostatolithotomy	Cured

TABLE II (*Continued*)

Case No. Name	Date of Exam.	Age	Symptoms	Clinical Findings	Roentgenologic Diagnosis	Urologic	Treatment Surgical	Results
27 A. R.	2-18-36	45	Severe cystitis with blood and pus in urine. Frequency, dysuria, bladder tenesmus. Painful urination, and pain in rectum and perineum	Prostate enlarged and boggy in consistency. Contains minute stones. Patient is acutely ill from severe cystitis. Arthritis and anemia	Plain film revealed three stones in bladder about the size of olives, with many round shadows of phleboliths in bladder and minute shadows of calculi in prostatic region	Bladder irrigations, urinary antiseptics and hot rectal douches	Suprapubic cystotomy for removal of bladder stones. Later perineal prostatolithotomy	Cured
28 W. J. P.	4- 9-36	68	Hematuria, dysuria, frequency day and night. Retention and difficulty	Prostate enlarged 2½ times. Boggy, adenomatous in type. 40 pus cells per H.P.F. Residual 4 oz. Minute prostatic calculi felt on rectal palpation	Multiple round shadows of phleboliths, in each side of bladder region. Small round shadows, of prostatic calculi in region of symphysis pubis	Cystoscopy revealed hypertrophy of median and lateral lobes, with multiple cystic degeneration of the mucosa of bladder neck	Endoscopic prostatic resection	Improved
29 F. R. V.	2-20-39	59	Frequency, day and night. Hematuria, tenesmus. Arthritis and hypertension	Microscopic hematuria, and pyuria. Cultures positive for streptococcus and staphylococcus	Multiple round shadows of prostatic calculi in prostatic region	Cystoscopy. Intravenous and retrograde pyelograms	Perineal prostatolithotomy advised. Operation refused	Unimproved

time, to complete the treatment by a perineal prostatotomy for removal of the offending prostatic calculi.

In the diagnosis of prostatic calculi, in addition to the history and the suggestive symptoms, the two most important factors are: First, the clinical findings by rectal palpation of the prostate—revealing the presence of hard nodules and the characteristic sensation of crepitation; and, secondly, the confirmation of the clinical diagnosis by the roentgenologic examination, including both excretory urograms and urethrocystographic studies.

In this series, the presumptive diagnosis was made by rectal palpation in only 67 per cent of cases, and was confirmed roentgenologically in all of them. It was made roentgenologically, however, in 93 per cent, and would undoubtedly have been made in 100 per cent, were it not that in two cases no roentgenograms were taken, because the patients, plainly suffering from prostatic obstruction, were submitted at once to perineal prostatectomy, without preliminary roentgenographic examination, and the minute prostatic calculi were an accidental finding in the specimen removed at operation.

TABLE III

ANALYSIS OF SURGICAL TREATMENT OF 29 CASES OF PROSTATIC CALCULI

Age	Number of Cases	Perineal Prostatolithotomy	Perineal Prostatectomy	Suprapubic Prostatolithotomy	Endoscopic Prostatic Resection	Cystoscopic Fulguration with Endoscopic Removal of Stone	No Operation	Totals
20–29	0	0	0	0	0	0	0	0
30–39	4	0	0	0	0	1	3	4
40–49	6	4	0	0	0	0	2	6
50–59	5	0	1	1	0	0	3	5
60–69	12	2	3	0	4	1	2	12
70–79	2	0	0	0	0	0	2	2
80–89	0	0	0	0	0	0	0	0
Totals	29	6	4	1	4	2	12	29

In Table III, it is seen that the largest group of patients is found in the fourth, fifth and sixth decades. The youngest patient was 30 years of age and the oldest 76. It was a common observation that in individuals over 50 years of age prostatic calculi were found in association with adenomatous prostatic hypertrophy, and, in younger men, in association with prostatitis; furthermore, that in some cases of prostatitis, that were refractory to the usual treatment, prostatic calculi were apparently the underlying cause of the long-standing prostatic infection. In two cases, there was evidence of prostatic abscess, which demanded surgical relief. Two cases exhibited the association of prostatic calculi with carcinoma. One of the latter, operated upon by perineal prostatectomy, lived comfortably for one year following operation, while the other, in whom symptoms of prostatic obstruction were relieved by endoscopic prostatic resection, is known to have lived in fair comfort for at least two years. One patient had a stone in the bladder, which was removed through the cystoscope, while the stones of the prostate were removed later by perineal prostatolithotomy. Another case had a diverticulectomy with partial cystectomy for a malignant growth within the diverticulum. No operation

was performed for the removal of the prostatic calculi, since the patient did not return for further treatments. There have been three cases with a clinical history of having voided small prostatic calculi on several occasions, particularly after prostatic massage. In a few instances, the characteristic click of the metal sound against the stones has been definitely heard. In one case there was definite evidence of association of minute prostatic calculi with calcification of the corpus spongiosum of the glans penis.

Most of the cases in which cultures of the prostatic fluid were made, were positive for several types of organisms, notably the streptococcus, colon bacillus and staphylococcus.

There was practically no case without evidence of 20 to 50 pus cells per high power field in the prostatic fluid, and in most, there was microscopic evidence of pyuria and hematuria in the routine examination of the urinary sediment.

The cystoscopic appearances in some of these patients were most interesting. In some, there was evidence of trilobar prostatic hypertrophy, producing definite obstruction, but it was seldom possible to see the calculi themselves. In one case the small stone was seen impacted in a prostatic diverticulum behind the verumontanum, possibly located in a dilated prostatic duct; this stone was removed by fulguration and endoscopic manipulations. It was striking to observe the presence of marked bullous edema in the floor of the bladder neck and in the region of the prostatic urethra—which appears to be a very constant and characteristic finding in these cases, and helps materially in establishing a correct diagnosis.

TABLE IV

RESULTS OF OPERATIVE TREATMENT IN 29 CASES OF PROSTATIC CALCULI*

	Cured	Improved	Unimproved	Totals
Perineal prostatolithotomy	6	0	0	6
Perineal prostatectomy	4	0	0	4
Suprapubic prostatolithotomy	1	0	0	1
Endoscopic prostatic resection	1	3	0	4
Cystoscopic fulguration	1	1	0	2
No operation	0	5	7	12
Totals	13	9	7	29

* *Summary:* Of 17 cases operated upon, 13 were cured, and four improved.
Of 12 cases not operated upon, seven showed no improvement.

In Table IV are summarized the results of the surgical treatment carried out in 29 cases of prostatic calculi. Of 17 cases operated upon, 13 were cured and four were improved; while of 12 cases that were not operated upon, some of whom were treated with routine urologic measures, five were somewhat improved, and seven showed no improvement.

The type of operation that appears most successful is perineal prostatolithotomy for the removal of the stones. This was performed in six patients, and all were cured. In older men, when the prostatic calculi are associated with adenomatous prostatic hypertrophy, perineal prostatectomy appears to be the procedure of choice. This was performed in four instances, with completely

satisfactory results. Suprapubic prostatolithotomy was also performed in one case, with good result. Cystoscopic fulguration with endoscopic removal of the calculus was performed twice. There were also two cases of recurrence of stone in the prostatic urethra after prostatectomy that were successfully removed by cystoscopic manipulations.

Endoscopic prostatic resection was performed in four cases, and of the four, one was considered cured. The other three were only improved, since all of them still have minor urinary symptoms, and even one to two ounces of residual urine, and the roentgenograms show that there are still multiple seed-like calculi present in the area occupied by the prostate, indicating that the transurethral procedure does not seem to be perfectly adapted to this type of pathologic condition.

Finally, it goes without saying, that every one of these patients who was operated upon was given a complete preliminary preparation for operation, including the repeated P.S.P. tests and blood chemistry, such as is required in a routine surgical case of prostatic obstruction. In fact, some of the cases associated with adenomatous prostatic hypertrophy required an indwelling catheter, and in one instance a preliminary cystostomy for drainage, in order to insure a successful perineal prostatectomy.

CONCLUSIONS

(1) Prostatic calculi are more frequently observed than one might believe from a study of the medical literature. In fact, they are rather a common finding, clinically, operatively and, especially, at autopsy.

(2) Etiologically, prostatic calculi may be classified in three groups: Endogenous—when they are formed in the substance of the gland; exogenous—when, coming from the upper urinary tract, they become deeply imbedded within the region of the prostatic urethra; and mixed or endo-exogenous—when, originating in the prostate, they come in contact with the exogenous elements of the urine which accelerates their growth so that they become in reality prostato-urinary calculi. The intimate interrelationship of these three types of prostatolithiasis may frequently be observed in the same individual.

(3) The most commonly accepted theory of the mode of formation of the minute intraprostatic calculi is that the corpora amylacea in the acini of the gland become surrounded with calcareous deposits, and thus act as nuclei for the development of the true prostatic calculi within the tubules of the prostate.

(4) For purposes of treatment, irrespective of their origin, all classes of prostatic stone, when producing symptoms, demand surgery for their removal.

(5) Asymptomatic stones are not surgical and demand no treatment, but patients in whom they are accidentally discovered should be kept under close observation, since they are harboring a latent infection which may lead to destruction of the parenchyma of the gland, producing obstruction and impairing function, causing abscess and chronic diverticulitis within the gland and even, in advanced cases, complete calcification.

(6) The association of prostatic calculi with parenchymal prostatitis and

adenomatous hypertrophy is a common occurrence. Most of the cases in this series have shown evidence of chronic or acute prostatitis, and, in eight patients, adenomatous prostatic hypertrophy was present.

(7) The symptomatology of this lithiasic disease is insidious. Some cases are asymptomatic, but frequently the patient is suffering from minor urinary, rectal or genital symptoms of an indefinite nature. All the patients in this series had urinary symptoms, ranging from mild frequency and dysuria to total hematuria and complete retention of urine, with all the characteristic symptoms observed as a rule in prostatic obstruction. A few patients complained of urethral stricture. In other instances arthritis or generalized sepsis of long standing was present as the result of prostatolithiasis.

(8) The diagnosis can often be made by rectal palpation of the gland, which in advanced cases elicits a characteristic crepitation and reveals the presence of hard nodules, which can be confirmed by the plain roentgenogram and by urethrocystographic examination.

(9) Cystoscopic examination is helpful in establishing an accurate diagnosis, particularly when there is prostatic hypertrophy or a characteristic bullous edema at the floor of the bladder neck and in the region of the prostatic urethra. It will also serve to determine the best type of operative procedure in each individual case.

(10) The diagnosis was made by rectal palpation in 67 per cent of the cases, and in 100 per cent of cases submitted to roentgenologic examination. No urographic examination should be considered complete without including the region of the prostate, since the discovery of clinically unsuspected prostatic calculi is common.

(11) Of 29 cases herewith reported, 17 came to operation, and, of these, 13 were cured and four improved. Of 12 cases not operated upon but treated medically and urologically, five were improved, and seven showed no improvement.

(12) The paramount surgical consideration is not merely the removal of all prostatic calculi, but is also the maintenance of open drainage, in order to relieve the infection and restore good function, if permanent cure is to be obtained.

(13) The best surgical treatment, when operative intervention is indicated, appears to be perineal prostatolithotomy. When the condition of prostatolithiasis is associated with adenomatous prostatic hypertrophy, perineal prostatectomy assures a permanent cure.

(14) Since the stones as a rule are multiple and in closed infected pockets in cases complicated with prostatitis, or lying near the capsule in cases of adenomatous prostatic hypertrophy, it appears that endoscopic prostatic resection is not applicable in the majority of these cases.

BIBLIOGRAPHY

[1] Albarran, J.: Concrétion et calculs de la prostate. Le Dentu et Delbet, Traité de chirurgie, 9, 579–582, Baillière et fils, Paris, 1900.

Idem: Prostate. In: Médecine opératoire des voies urinaires, p. 731–855, Masson et Cie, 1909.

[2] Amussat: Leçons sur les rétentions d'urine. Paris, p. 215, 1832.

[3] Bartoletus, Fabricius: Cited by Tarnaud.

[4] Bernard: Maladies de la prostate. Thèse d'agregation, Paris, 1847.

[5] Brongersma: Deux cas de calculs prostatiques. Assoc. franç. d'urol., p. 657, 1909.

[6] Caraven and Lourdel: Calculi after Prostatectomy. J. d'urol., **14**, 111–132, 1922.

[7] Marcet and Civiale: Traité de la pierre et de la gravelle. Paris, Mal. d. org. gén.-urin., 2, 352, 1838; 3, 81, 1840.

[8] Clark, J. B.: Calculous Replacements of the Prostate. Jour. Urol., **32**, 495–500, 1934.

[9] Corlineau: Calcul prostato-vésical. J. d'urol., **34**, 199–211, 1932.

[10] Delauney: Contributions à l'étude des calculs de la prostate. Thèse de Paris, 1903–1904.

[11] Donatus, Marcellus: De medica historia, 1586.

[12] Douglas, Jacobus: Oct. erud. Lips, 1707.

[13] Englisch: Arch. f. klin. chir., **72**, 487, 1904.

[14] Gayet, G.: Calculs de la prostate: leur étiologie, symptomatologie et traitement. J. d'urol., **15**, 305–323, 1928.

[15] Gläsel, F. A.: Calculi prostatici veri. Ztschr. f. urol. Chir., **2**, 353, 1914.

[16] Guiard: Lithotritie urétrale appliquée au traitement des calculs de la region prostatique. Ass. franç. d'urol., p. 328, 1899.

[17] Grannuzzi: Grosso calcolo prostatico vero. Arch. ital. di chir., **18**, 1927.

[18] Gutierrez, R.: Later Results of Surgery of the Seminal Vesicles. Report of One Hundred Consecutive Seminal Vesiculectomies. J.A.M.A., **93**, 1944–1951, 1929.

Idem: Transurethral Treatment of Bladder Neck Obstructions. Endoscopic Prostatic Resection. History of Urology, Chap. V, **2**, 137–186, Baltimore, Williams and Wilkins Company, 1933.

Idem: A New Device for Catching Tissue in Endoscopic Prostatic Resection. Urol. and Cutan. Rev., 38, 91–93, 1934.

Idem: Surgery of the Seminal Vesicles, Ampullae and Vasa Deferentia. Oxford Loose-Leaf Surgery, **III**, Pt. 2, 301–509, New York, Oxford University Press, 1935.

Idem: Primary Carcinoma of Cowper's Gland. Surg., Gynec., and Obstet., **65**, 238–248, August, 1937.

Idem: The Changing Conception of Cancer of the Prostate. Am. Jour. Surg., **43**, 330–341, May, 1940.

[19] Gutierrez and Lowsley: Chirurgische Behandlung der Harndivertikel mit Projektion. Verhandl. d. deutsch. Gesell. f. Urol., VIII Kong. in Berlin, 1929.

[20] Guyon: Des calculs de la région prostatique. Ann. d. mal. d. org. gén.-urin., **17**, 1–14, 1899.

[21] Hamer and Dykhuizen: Prostatic Calculi. Am Jour. Surg., **24**, 119–123, 1934.

[22] Hinman: Perineal Prostatectomy. Surg., Gynec., and Obstet., **49**, 669–681, 1929.

[23] Home, E.: Practical Observations on the Treatment of Diseases of the Prostate Gland. London, W. Bulmer & Co., p. 70, 1818.

[24] Hubeny, M. L.: Prostatic Calculi from Roentgen Ray Diagnostic Standpoint. Am. Jour. Roentgenol., **6**, 286–289, 1919.

[25] Joly: Stone and Calculous Disease of the Urinary Organs. C. V. Mosby Co., St. Louis, 1929.

[26] Judd, E. S., Parker, B. R., and Morse, H. D.: Urinary and Prostatic Calculi. Surg. Clin. N. Amer., **5**, 655–672, 1925.

[27] Judd, E. S., and Crenshaw, G.: Minnesota Med., **2**, 52–56, 1919.

[28] Kretschmer, H. L.: True Prostatic Calculi; Clinical Data Based on Seventy-Six Cases. Surg. Gynec. and Obstet., **44**, 163–168, 1927; **26**, 70–80, 1918.

[29] Legueu: Des calculs de la portion prostatique de l'urètre. Ann. gén.-urin., 1895, p. 769.

[30] Lessius, F.: Cited by Tarnaud.

[31] Louis: Mémoires sur les pierres urinaires. Acad. Roy. de chir., **3**, 332, Paris, 1747.

[32] D'Etiolles, Leroy: Hypertrophie de la prostate avec un ancien abscès de la glande contenant plusieurs calculs. Bull. Soc. anat. de Paris, 1860.
[33] MacKenzie and Seng: Jour. Urol., 12, 243, 1924.
[34] Malteste: Des calculs de la prostate. Thèse de Paris, 1876.
[35] Mariani: Contributions à l'étude des calculs de la prostate. Th. Montpellier, 1906–1907.
[36] Martin, Pulido A.: Prostatectomy with True Prostatic Stones. Siglo med., 81, 109–111, 1928.
[37] Mélisson: Cited by Tarnaud.
[38] Ménagé: Calculs de la prostate. Thèse de Paris, 1880.
[39] Moore, R. A.: The Morphology of Prostatic Corpora Amylacea and Calculi. Arch. Path., 22, 24–40, 1936.
[40] Moore, R. A., and Hanzel, R. F.: Chemical Composition of Prostatic Calculi. Arch. Path., 22, 41–54, 1936.
[41] Morgagni: Adversaria anatomica. Venetiis, 1762, 42d letter.
[42] Nicolich: Énorme calcul de la prostate. Assoc. franç. d'urol., 1909, p. 656.
[43] Olivieri, G.: Large Prostatovesical Calculus in Child. Pediatrics, 35, 946–951, 1927.
[44] Oraison, J.: Concrétions et calculs de la prostate. Enc. franç. d'urol., 6, 389–401, Gustave Doin, Paris, 1923.
[45] Pasteau, O.: Étude sur les calculs de la prostate; anatomie pathologique et pathogénie. Ann. des mal. des org. gén.-urin. Paris, 1901, p. 416.
[46] Pohl: Prostates affectées d'un calcul., 1737.
[46a] Posner, C.: Pathologische Erkrankungen der mannlichen Geschlechtsorgane. p. 530–549, Handbuch der Urologie (von Lichtenberg), Berlin: J. Springer, 1926.
[47] Pousson: À propos de deux cas de calculs endoprostatiques. Assoc. franç. d'urol., p. 725, 1911.
[48] Proust: La prostatectomie dans l'hypertrophie de la prostate. Masson et Cie., Paris, 1904.
[49] Randall: Surgical Pathology of Prostatic Obstructions. Williams and Wilkins Co., Baltimore, 1931.
[50] Ravasini: Calcolo della prostata del peso di 320 gr. Fol. urol., 190, IV, I. P. 49.
[51] Robin: Leçons sur les humeurs normales et morbides du corps de l'homme. Paris, 1874.
[52] Tanton, J.: La lithiase prostatique. Rev. clin. d'urol., 1, 15–25 and 141–150, 1912.
[53] Tarnaud, R.: Les calculs de la prostate. Thèse de Paris, June, 1901.
[54] Thomas, B. A., and Robert, J. T.: Prostatic Calculi. Jour. Urol., 18, 470–493, 1927.
[55] Thompson, H.: Diseases of the Prostate: Their Pathology and Treatment. London, 1861.
[56] Thompson, G. J.: Transurethral Operations: Changing Conception During the Past Five Years. J.A.M.A., 107, 1954–1960, 1936.
[57] Velpeau: Des calculs de la prostate. Gazette des hôpitaux. Paris, 1842.
[58] Vidal de Cassis: Calculs de la prostate. Journal des conn. médicales, Paris, 1840.
[59] Virchow: Structure and Composition of the Corpora Amylacea in Man. Verhandl. der physikal. med. Gesellsch., Wuerzburg, 2, 51, 1852.
[60] von Frisch: Les Maladies de la Prostate. Jules Rousset, Paris, 1903.
[60a] Walker, Sir J. W. Thomson: Surgical Diseases and Injuries of Genito-Urinary Organs. p. 739–741, New York, Funk & Wagnalls, 1914.
[61] White, H. P. Winsbury: Stone in the Urinary Tract. J. and A. Churchill, London, 1929.
[62] Young, H. H.: Prostatic Calculi. Jour. of Urol., 32, 660–709, 1934.

HYDROCELE OF THE CANAL OF NUCK

REPORT OF SEVENTEEN CASES

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SINCE Coley's[3] comprehensive review of the literature and report of 30 new cases, in 1892, the literature on the subject of hydrocele of the canal of Nuck has been limited mostly to single case reports and the various features of the condition have been neglected. Price,[11] in 1926, expressed the belief that the condition was sufficiently rare to warrant reporting a single case, and he was able to find only eight references in the literature between 1908 and 1926. In the Quarterly Cumulative Index Medicus, since 1926, only three references to it are listed; two are reports of a single case and the third is to an article under the general title, "Hydrocele of Nuck in Japanese Women."

The number of previously reported cases is not large. Wechselmann,[15] in 1890, was able to collect only 62 cases from the literature, and Coley[3] added 30 cases to this list, in 1892. Coley,[4] in 1908, stated that 160 cases of hydrocele of the canal of Nuck had been encountered at the Hospital for Ruptured and Crippled between 1890 and 1908. Since 1892, probably less than 100 cases have been reported. This statement is based on a rather careful search through the "Index-catalogue of the Library of the Surgeon General's Office" and the Index Medicus, and the careful checking of all references available. Several German theses on the subject that have appeared during this period were not available nor were a few reports in more obscure journals. However, we feel that an estimate of less than 350 reported cases is probably not too high. We were unable to find any statistics concerning the incidence of the condition or data relative to the proportion of inguinal herniae complicated by hydrocele among women.

The present communication was undertaken because of the recent lack of interest in the condition, as reflected by references in the literature, and to report the cases encountered at the Mayo Clinic.

Development.—Most writers on the subject are agreed that the cystic tumors which accompany the round ligaments through the inguinal canal of women are the exact counterpart of encysted hydroceles of the cord in the male, and result from the accumulation of fluid in a persisting diverticulum of Nuck, which corresponds to the vaginal process of the peritoneum in the male. In keeping with this conception of origin of the cysts, they are usually

Submitted for publication October 25, 1939.

found accompanying the round ligament but not originating within it, and they are lined with a pavement epithelium similar in all respects to the cells lining the peritoneal cavity. As in the male, the more common form does not communicate with the peritoneal cavity but Coley has reported cases in which such communications exist. In most textbooks essentially the same explanation of the condition is given. Thus Graves[7] considered hydrocele of the vulva to be "a retention cyst due to the upper closure of the processus vaginalis peritonei which runs along the round ligament into the labium majus." Davis[5] stated: "Sometimes a finger-like extension of the peritoneum resembling the vaginal process in the male" accompanies the round ligament through the inguinal canal and the accumulation of fluid in this leads to the formation of the hydrocele.

Other theories to explain the development of these cysts have been proposed in the past. Gebhard[6] suggested that they originated from embryonic rests in the round ligaments, and Weber[14] thought that they could result from the persistence of the original hollow condition of the round ligament. Brothers[1] considered these older theories more completely but they have been largely abandoned at present. It is evident that when a cyst does not have a simple lining of flat cells, it cannot be considered to be an hydrocele and some other explanation for the presence of the epithelial lining must be sought. In most cases reported recently, in which a definite epithelial lining has been found, a cystic adenoma has been present.[10] Further discussion of this point is beyond the scope of this report. However, other cysts than hydroceles do exist in the inguinal canal and in the vicinity of the round ligaments so that microscopic examination of the wall of the cyst is necessary for exact diagnosis.

Classification.—The most common type of hydrocele of the canal of Nuck corresponds to the encysted hydrocele of the cord in the male. There is no communication with the peritoneal cavity and the cyst may be found anywhere along the course of the round ligament from the internal ring to the vulva. Such hydroceles may be multilocular and most of the larger ones have incomplete partitions.

A second type corresponds to the congenital hydrocele of the male with a communication between the hydrocele and the general peritoneal cavity. Two of the cases collected by Coley were of this category without question and several other cases in his series were probably of this type.

Hydroceles of hour-glass type have been found among women also. Halstead and Clark[8] reported a case of a bilocular hydrocele in a Negress, age 42. The constriction was situated at the internal ring where the round ligament entered the lower sac and, in the same region, there was a free communication with the general peritoneal cavity. The upper sac was intra-abdominal but outside of the peritoneum, whereas, the lower sac was in the inguinal canal and simulated an hernia. The lower sac contained several septa and a bean-shaped free body. Halstead and Clark also referred to a similar case reported by Thierhaber,[13] in which there was no communication with the peritoneal cavity, and to a third, reported by Chiari.[2] In both of these cases inflammation

in the intra-abdominal portions of the sac gave symptoms of serious intra-abdominal disease which were interpreted, in both cases, as intestinal obstruction.

The original classification of Regnoli included hydroceles developing in an hernial sac as well as the encysted and diffuse hydroceles of the cord and the congenital type.

Diagnosis.—The chief importance of the condition lies in the differential diagnosis, chiefly from hernia. Coley believed that the diagnosis was possible in most cases and emphasized the characteristic elastic feel of the cyst, along with its position at the subcutaneous inguinal ring. He further pointed out that hydroceles of the canal of Nuck appear first at the subcutaneous inguinal ring and only later reach the vulva. A careful history, therefore, should serve to distinguish hydrocele from vulvovaginal cysts. Others have emphasized the lack of an impulse on coughing and the fact that the supposed hernia cannot be reduced.

In the 17 cases reviewed from the Mayo Clinic, the differential diagnosis between hernia and hydrocele in the female was very difficult. In most of the cases, rather small tumors were so well confined to the inguinal canal that they could not be palpated readily. Many of the hydroceles were associated with hernia and this confused the question of whether the mass could be reduced and whether there was an impulse on coughing. In some cases the cysts were small enough to be freely movable and to be forced toward the subcutaneous inguinal ring when the patient stood or strained. In virtually all such cases the findings indicated to the examiner the presence of a reducible hernia.

In cases in which the hydrocele had extended beyond the subcutaneous inguinal ring toward the vulva, the findings were more diagnostic. Palpation was much facilitated and the mass could be transilluminated. It was also evident that these tumors could not be reduced completely and that they were not incarcerated herniae.

It was often impossible, particularly among obese patients, to place the hydrocele definitely in the region of the subcutaneous inguinal ring rather than over the femoral ring. It was also impossible to distinguish, with complete certainty, small hydroceles from intrinsic tumors of the round ligament, such as fibromata and lipomata.

A clinical diagnosis of hydrocele of the canal of Nuck presents no particular difficulty when the hydrocele is not associated with hernia or when it is large enough to permit transillumination, careful palpation, and the proper determination of its position in relation to the femoral and subcutaneous inguinal rings. In addition, the history of a nontender, irreducible tumor which is slowly increasing in size would make the diagnosis virtually certain. However, smaller hydroceles, particularly those in association with hernia and those in obese patients, probably cannot be differentiated from other tumors in the inguinal and femoral regions.

Data on seventeen cases.—Seventeen cases of hydrocele of the canal of Nuck proved at operation have been encountered at the Mayo Clinic. Although the condition undoubtedly has escaped diagnosis in a few cases, the finding of so few cases of sufficient importance to treat, would indicate the rarity of the condition. The oldest patient in the series was 51 and the youngest, 28 years. The average age at the time of operation was 37. None of the hydroceles had been noted during childhood and the earliest age at which any patient noticed symptoms was 20. Eleven patients had noted tumor in the inguinal region, and the tumor of four others was found on physical examination. The average duration of symptoms was 19 months. The longest time that a mass had been noticed was 16 years; the shortest, two weeks. The duration of the mass, as noticed by the patient, had no relation to its size. Thus the patient who had had the tumor for 16 years had an hydrocele the size of a plum (about 5 cm. in diameter) which had not increased perceptibly in size throughout this time. The largest hydrocele had been noted for 30 months and, during this time, had slowly increased in size. Only one of the 17 patients complained of spontaneous pain and tenderness, while one patient found that wearing a truss caused pain.

For the most part the cysts were small, averaging about 2 to 3 cm. in diameter and their location was such that, in the majority of cases, a diagnosis of inguinal hernia was made. In the 11 cases in which the diagnosis of inguinal hernia was made before operation, an impulse on coughing was thought to have been present, and in all but two the mass was thought to be at least partially reducible. In two cases a diagnosis of femoral hernia was made before operation; only two cases were correctly diagnosed preoperatively; in two cases in which the hydrocele was almost entirely within the abdomen, no preoperative diagnosis was made, the patients having been operated upon for some unrelated condition. In both cases in which a correct preoperative diagnosis was made, the hydroceles were large, extended into the vulva and could be transilluminated.

The frequent association of inguinal herniae with hydroceles in the female has been stressed by several authors previously (Coley, Johnson,[9] and others). This fact was of considerable importance in the past, when the standard treatment for the hydrocele was the injection of some irritant, usually tincture of iodine, into the sac after aspiration of the contents. In our series, seven of the 17 patients had an associated inguinal hernia. In one case, the hydrocele may have occurred in the hernial sac, but in the others both hydrocele and hernia were present. This definite association of hernia with hydrocele in more than one-third of this series of cases, seems to be of considerable importance if any but operative methods are chosen for treatment.

Two of the hydroceles in this series were of the hour-glass type with the larger loculus located within the abdomen. In one of these cases a questionable preoperative diagnosis of femoral hernia was made, while in the other inguinal hernia was thought to have been present. In both cases, rather large extraperitoneal cysts were found, without free communication with the

peritoneal cavity. In neither case was the presence of an intra-abdominal portion of the hydrocele diagnosed before operation. In one case, operative intervention was performed for the supposed inguinal hernia and in the other for leiomyomata of the uterus.

Eight hydrocele sacs of the canal of Nuck were available for microscopic study. Sections from various parts of the walls were made on the freezing microtome and stained with hematoxylin and eosin. In all cases, the hydroceles were lined with a single layer of flattened cells, indistinguishable from the lining cells of the peritoneum. The remainder of the wall was composed of fibrous tissue which was most dense immediately beneath the free surface. The walls varied considerably in thickness and, in the thicker portions, were surprisingly vascular. In two of the smaller cysts with thick walls, bundles of smooth muscle cells independent of the blood vessels were found. The presence of these cells probably can be explained on the basis of the round ligaments, blending into the walls of the hydrocele in this region. In none of the eight cases studied, could the tissue in the lining be interpreted to be cuboidal or columnar epithelium.

Because of the few cases recently reported, a summary of our 17 cases is included (Table I).

TABLE I

SUMMARY OF DATA ON 17 CASES OF HYDROCELE OF THE CANAL OF NUCK

Case	Age	Duration	Size	Side	Hernia	Remarks
1	44 yrs.	2/3 yr.	3x7 cm.	R.	None	Impulse on coughing, reducible mass
2	41 yrs.	5/6 yr.	Lemon-size; inguinal region. Large cyst in iliac fossa	R.	None	Impulse on coughing, reducible mass; hour-glass type of hydrocele
3	46 yrs.	6 wks.	2x3 cm.	L.	None	Extended into labia
4	31 yrs.	*	Large cyst	R.	None	Chiefly intra-abdominal hour-glass type
5	35 yrs.	1/6 yr.	2½ cm.	L.	L. inguinal	Firm; movable in inguinal canal
6	37 yrs.	5 yrs.	Small	R.	R. inguinal	Impulse on coughing, reducible mass
7	51 yrs.	½ yr.	Hickory nut	L.	None	Pain extending down left leg, worse with menses
8	28 yrs.	*	?	L.	L. inguinal	Diagnosis made at operation
9	47 yrs.	*	?	R.	None	Diagnosis made at operation; hydrocele drained from inside of abdomen
10	36 yrs.	16 yrs.	Plum-size	L.	L. inguinal	Truss caused pain
11	30 yrs.	*	?	R.	R. inguinal	Hydrocele of hernial sac
12	40 yrs.	2 wks.	5x3x3 cm.	L.	L. inguinal	Reducible mass; impulse on coughing
13	37 yrs.	*	Small	L.	None	Impulse on coughing; sudden onset of pain; tenderness; mass became irreducible
14	39 yrs.	6 wks.	Egg-size	L.	None	Reducible mass; impulse on coughing; multilocular hydrocele
15	37 yrs.	*	?	R.	None	
16	45 yrs.	7 yrs.	Contained 6 cc. of fluid	L.	Bilateral; inguinal	Left hernia irreducible
17	42 yrs.	2½ yrs.	12x9x3 cm.	L.	None	Extended into labia; many incomplete septa in hydrocele

* Hydrocele found on physical examination or at operation.

SUMMARY AND CONCLUSIONS

The question of the incidence of hydrocele of the canal of Nuck cannot be answered. The small number of reported cases together with the rarity of the diagnosis at the Mayo Clinic is at variance with some previous reports. The diagnosis presents much difficulty, particularly when the hydrocele is confined to the inguinal canal and is too small or is so placed that adequate palpation and transillumination cannot be employed. The finding of an impulse on coughing and the apparent reducibility of the mass cannot be relied on to distinguish hernia from hydrocele in the female. Hernia was associated with hydrocele in seven of the 17 cases in our series. The most important differential diagnostic procedure to distinguish hernia from hydrocele is transillumination. The wall of the hydrocele is made up chiefly of fibrous tissue with a single layer of flattened cells on the inner surface. Smooth muscle may be present in the wall but its finding is not constant.

REFERENCES

[1] Brothers, A.: Report of a Case of Cyst of the Round Ligament. Am. Jour. Obstet., 48, 70–75, 1903.

[2] Chiari: Quoted by Halstead, A. E., and Clark, C. P.[8]

[3] Coley, W. B.: Hydrocele in the Female; with Report of Fourteen Cases. ANNALS OF SURGERY, 16, 42–59, 1892.

[4] Coley, W. B.: Hernia. In: Keen, W. W., and Da Costa, J. C.: Surgery, Its Principles and Practice. 4th edit., Philadelphia, W. B. Saunders Company, 1908, p. 58.

[5] Davis, G. G.: Applied Anatomy: The Construction of the Human Body Considered in Relationship to Its Functions, Diseases and Injuries. 9th edit., Philadelphia, J. B. Lippincott, 1934, p. 439.

[6] Gebhard: Quoted by Brothers, A.[1]

[7] Graves, W. P.: Gynecology. 4th edit., Philadelphia, W. B. Saunders Company, 1928, p. 323.

[8] Halstead, A. E., and Clark, C. P.: Hydrocele in the Female. ANNALS OF SURGERY, 41, 740–744; 796–797, January, 1905.

[9] Johnson, J. A.: Hydrocele of Round Ligament. Lancet Clinic, 113, 614, May 29, 1915.

[10] Martin, W. S.: Case of Cyst of the Round Ligament Simulating Inguinal Hernia (short résumé of the literature). Jour. Michigan Med. Soc., 36, 572–573, August, 1937.

[11] Price, J. W., Jr.: Hydrocele Muliebris; Report of a Case. Am. Jour. Surg., 1, 30–32, July, 1926.

[12] Regnoli: Quoted by Wile, W. C.: Hydrocele in the Female. Am. Jour. Obstet., 14, 584–596, July, 1881.

[13] Thierhaber: Quoted by Halstead, A. E., and Clark, C. P.[8]

[14] Weber: Quoted by Brothers, A.[1]

[15] Wechselmann: Quoted by Coley, A.[3]

BRIEF COMMUNICATIONS AND CASE REPORTS

PARTIAL GASTRIC RESECTION FOR CARCINOMA*

TWO CASE REPORTS OF FIVE-YEAR SURVIVALS

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I WISH to briefly present two patients whom I have treated surgically for gastric carcinoma. The first is that of a man of carcinoma age whose symptoms should have led to a much earlier diagnosis. He was treated by several physicians over a period of 15 months, and was undiagnosed until he was observed to have a prominent epigastric tumor.

The second case was a much younger individual who, for ten years had been under care for a peptic ulcer and who, it is believed, was properly diagnosed within a few weeks of the development of a gastric carcinoma. This early diagnosis, which is so highly desirable in the treatment of gastric carcinoma, was the result of frequent and careful examination.

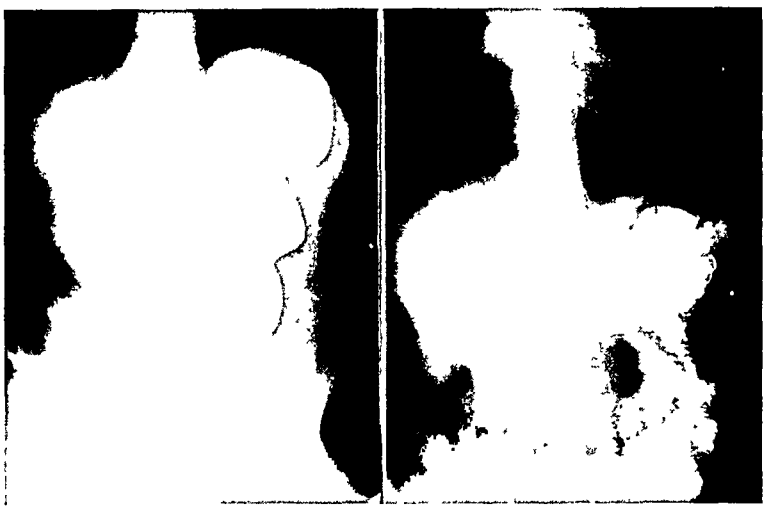
CASE REPORTS

Case 1.—New York Hospital, No. 47644: J. P. C., male, age 50, was admitted, December 11, 1933, because of indigestion. His symptoms dated back 15 months when he first experienced severe and intractable diarrhea. This persisted for three months and then diminished. It was followed by a six months' period of transient nausea and later occasional vomiting. Six months prior to admission the patient began to vomit almost all the food he ingested. He then became constipated. Roentgenologic examination at that time was said to have been negative. However, because of his symptoms he was told by several physicians that he had a variety of lesions. He was directed, by a friend, to an "Indian" doctor who prescribed a mixture of herbs which relieved the constipation. For two months prior to admission, the patient was able to retain only liquids, he was constantly nauseated, and had a sense of fullness in the epigastrium. From the onset of his symptoms until the patient entered the hospital he had lost between 30 and 35 pounds in weight.

Physical Examination revealed a well-developed but somewhat emaciated individual. The mucous membranes and skin were pale. There was no palpable Virchow's node, and the chest examination was negative. A definite arteriosclerosis was present. Blood pressure 104/74. The abdomen was scaphoid and the superficial veins were prominent. Just above, and to the right of the umbilicus there was a firm, hard, rounded mass, approximately 15 cm. in diameter, which seemed to be connected with a dilated, palpable stomach lying above and to the left of it. The mass was movable and could be dislocated in an orbit of about 20 cm. The liver and spleen were not palpable. Rectal examination was negative.

* Presented before the New York Surgical Society, November 8, 1939. Submitted for publication January 10, 1940.

Laboratory Data.—R B. C. 4,200,000; Hb. 88 per cent; W. B. C. 11,200. Differential, normal. Urine, negative. Stool examination, repeatedly 4+ for occult blood. Blood Wassermann negative. Gastric analysis: material aspirated was foul-smelling, containing necrotic tissue and blood clots. No free acid was demonstrable. Roentgenologic examination revealed a large, dilated stomach with an obstructive type of peristalsis. There was a huge filling defect with a moth-eaten appearance involving the distal one-third of the stomach (Fig. 1 A). A six-hour examination showed practically complete retention. A 24-hour examination revealed a 75 per cent retention of barium. Doctor Weintraub's impression was carcinoma of the pyloric end of the stomach. A chest roentgenogram showed no evidence of metastasis.



A B

FIG 1.—Case 1. (A) Roentgenogram taken preoperatively, November 20, 1933. (B) Roentgenogram taken October 30, 1939.

Operation.—December 14, 1933: Ethylene anesthesia. A tumor was found, which measured approximately 12 x 20 cm., involving the distal one-third of the stomach, beginning along the lesser curvature and extending both anteriorly and posteriorly. There were a few enlarged lymph nodes in the mesentery along the lesser curvature. There were no evidences of metastases in the liver, and no free fluid in the abdomen. Between one-third and one-half of the distal portion of the stomach was removed; a Billroth II type of resection being performed. The patient's postoperative course was entirely uneventful.

Pathologic Examination.—Gross: A segment of the stomach showed a large cauliflower mass arising from its lesser curvature. This measured 14 cm. in diameter and projected about 3 cm. above the level of the mucosa. It was composed of papillary, injected, soft masses covered by a yellowish, mucoid secretion. There was a margin of about 3 cm. of normal gastric wall at the cardiac and pyloric portions of the stomach beyond the lesion. There were several large, firm lymph nodes along the lesser curvature. Sections of six of these were taken for microscopic examination. The serous layer of the stomach was smooth and slightly roughened in places, but there was no apparent penetration of the growth into its substance.

Microscopic.—Sections through the tumor showed a profuse growth of neoplastic glandular tissue that extended outward from the mucosa. A very thin connective tissue framework supported large tubular structures made up of columnar epithelium with basally situated nuclei and a clear, unstained cytoplasm. Considerable mucoid material lay in the lumina of these. The growth did not quite extend through the muscular layers. Considerable tissue reaction was evidenced by large numbers of lymphocytes and plasma cells in the submucosa. Sections of six of the regional lymph nodes showed

edema and increase in the retothelial elements, but no evidence of cells of a malignant neoplastic type. Sections through the marginal stomach wall immediately adjacent to the tumor showed considerable inflammation, but no evidence of tumor invasion.

The postoperative course of the patient was uncomplicated, other than for a definite, slowly progressive cerebral arteriosclerosis. The patient has been observed at six-month intervals in the Surgical Follow-Up Department. He has increased in weight from 102 to 133 pounds. The last gastro-intestinal series was made October 30, 1939, and was reported by Doctor Weintraub as revealing a small stomach with a Billroth II operation. The stoma was well placed and functioned normally (Fig. 1 B). There was no evidence of recurrence.

This is an example of a patient of carcinoma age who came to the hospital with a history of gastro-intestinal symptoms of 15 months' duration, which is, in retrospect, almost pathognomonic of carcinoma of the stomach. A partial gastric resection for a palpable tumor was performed. Now, almost six years after operation, he exhibits no evidence of metastases.

Case 2.—New York Hospital, No. 2585: E. P., female, age 37, was admitted to the New York Hospital complaining of epigastric pain. Her history, extending back for ten years, was compatible with duodenal ulcer. She had been seen in 1932 in the Medical Clinic and was found to have epigastric tenderness and roentgenolographic evidence of a duodenal ulcer. She improved on a dietetic ulcer regimen, alkalies and belladonna; sometime later a gastro-intestinal series was reported as being negative. One year prior to admission, the patient had a recurrence of all her symptoms and roentgenologic examination revealed a prepyloric ulcer with a crater (Fig. 2 A). A gastric analysis showed free acid 44; total 60. On rigid treatment she improved, until one month before admission when her symptoms reappeared, and could not be controlled by medical treatment. For a month prior to admission she had vomited practically once a day. No bloody or coffee-ground material was observed in the vomitus. She had lost about 20 pounds in weight.

Physical Examination revealed a thin young woman who showed some evidence of recent loss of weight. The skin and mucous membranes were pale; the lungs clear; blood pressure 140/92. There was slight tenderness in the epigastrium. The remainder of the examination was negative.

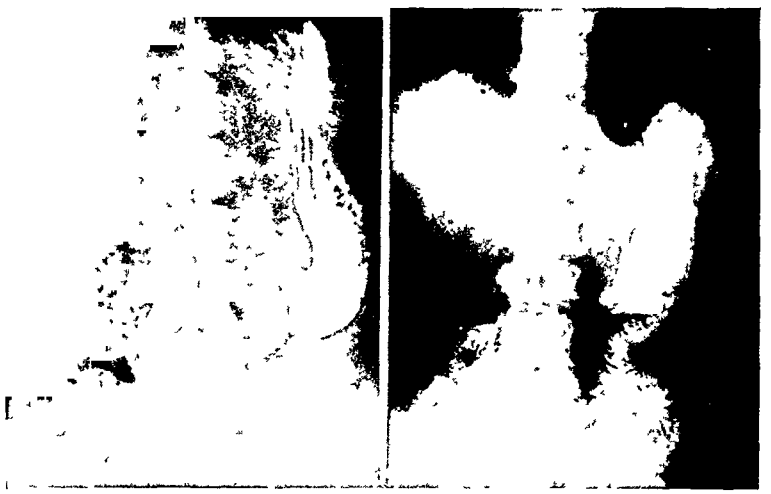
Laboratory Data.—R. B. C. 4,400,000; Hb. 80 per cent; W. B. C. 7,900. Differential, normal. Urine, negative. Wassermann, negative. Gastric analysis showed a total acidity of 20, free acidity of 4. Stools, 4+ for occult blood. Roentgenologic examination of the stomach showed an irregular narrowing of the pyloric end of the stomach and a gastric ulcer, with a crater. The findings were interpreted by Doctor Weintraub as those of a carcinoma of the pyloric portion of the stomach.

Operation.—November 23, 1934: An indurated, crater-like ulcer, 2.5 cm. in diameter and 2.0 cm. deep, was found on the posterior wall of the prepyloric region of the stomach. The regional lymph nodes were not apparently involved. In addition, there was scarring, suggesting a healed duodenal ulcer. A Billroth II type of resection was performed, removing one-third of the distal portion of the stomach. The patient's postoperative course was uneventful.

Pathologic Examination.—Gross: The specimen consisted of the distal portion of the stomach. On the posterior aspect of the lesser curvature there was a deep, crater-like ulcer measuring 2.5 cm. in diameter and 2.0 cm. deep. It had a firm, irregular edge with a grayish, dirty coating over the ulcerated surface. At one point in the base of the ulcer, the stomach wall was only 2 Mm. in thickness. There was some puckering and induration externally around the area of the lesion. The remainder of the mucosa appeared normal. There were no enlarged lymph nodes accompanying the specimen.

Microscopic.—Sections from the gastric lesion showed the ulcer to be covered by a

degenerated fibrinopurulent exudate. Beneath this area there was a dense connective tissue with a scattered infiltration of lymphocytes, plasma cells and eosinophils. Throughout this region there were many small groups of large, irregular cells which were rather hyperchromatic, had a large, oval nucleus, prominent nucleolus and frequent mitotic figures. These cells were arranged in small gland-like structures or in groups or cords of two or three. Some normal mucosa was shown on the edge of the section, but this region, likewise, was infiltrated in the deep tissue by cells of similar appearance to those described above.



A B

FIG 2.—Case 2 (A) Roentgenogram taken preoperatively, November 21, 1934. (B) Roentgenogram taken October 30, 1939

Postoperatively the patient has been symptom-free. A gastro-intestinal series, October 30, 1939, showed a stomach with the Billroth II operation (Fig. 2 B). Doctor Weintraub reports: "Stoma of the gastro-enterostomy is well placed and functioning normally. There is no evidence of metastasis or recurrence."

This is an example of a patient with a history of ulcer of ten years' duration. A duodenal ulcer was diagnosed, and apparently relieved by treatment. There followed a gastric ulcer which failed to respond to treatment and was proven to be a carcinoma. Five years after operation she shows no evidence of metastases.

DISCUSSION.—DR. GEORGE T. PACK (New York) said that his interest in these two case reports by Doctor Glenn has to do with certain factors in prognosis which they illustrate quite well. Both patients are to be congratulated not only because they came under Doctor Glenn's capable care and survived partial gastrectomy for cancer but, of equal importance, because of the type of cancer which they had, representing the two most favorable varieties or gross anatomic types of cancer of the stomach. In the first, it was a bulky, papillary exophytic tumor growing into the lumen and, although invading the wall, not metastasizing to regional nodes—a tumor which belies its bulk by a relatively slow course and attended by a good prognosis. On microscopic section, it is apparent that it is of low grade malignancy—Grade 1, or Grade 2. The second tumor was an instance of cancer developing on an ulcer in a patient who, until the last few months, at least, had hyperacidity. This patient, also, was without regional metastasis to the nodes. Of course,

these two patients represent successful results of surgery. If one is to be able to present cured patients five years after detection or diagnosis of the cancer is made, a radical procedure such as gastrectomy must be employed.

Palliative operations for gastric cancer are never successful enough to permit the surgeon to present his patients five years after operation, if he employs such procedures as jejunostomy, gastrostomy, simple exploration alone, or plus radiation. The longest duration of life after jejunostomy, in a survey recently made by Doctor Pack, is six months; after gastrostomy 16 months; after simple exploration, plus interstitial radium, 14 months.

One can rest assured that if Doctor Glenn's hospital is comparative to other hospitals in the country, that, at the end of five years, the very best figures will be only 4.5 per cent cures of the total numbers of patients with gastric cancer seen. In other words, for the two patients shown to-night, it may be assumed that there have been 50 who applied to the institution, in the same period, who have died of the disease. His two cases represent the successful end-results in those 50 patients. The statistics collected by Doctors Livingstone and Pack, to which Doctor Pack referred, were collected from the time of Billroth's original report down to January, 1939, representing more than 2,000 references to the world literature.

Of 100 patients coming to the hospital with cancer of the stomach, and seeking cure, 40–80 per cent are immediately incurable, because, at the time they come, they are inoperable. They are not even suitable for celiotomy, even for exploration, or for gastro-enterostomy. The operability rate, therefore, varies from 60 to 20 per cent. Only about 50 out of 100, in the very best hospitals, are suitable to have the abdomen opened. Forty to 60 per cent of these remaining patients are lost as soon as the abdomen is opened, because only palliative operations are found to be possible. Therefore, we have left only a small percentage which, in the average accredited hospital, is only 25 per cent of the 100 patients coming in with gastric cancer. Only one out of four can have a resection—let alone five-year survival. Of those who have the gastric cancer removed, a certain percentage die of the operation, this operative mortality varying from 10 to 60 per cent. The operative mortality is high in some of our best hospitals. If we subtract the operative mortality, the balance represents where cure can begin; this is only 15 or 20 of the original 100 who came in. Following through, then, for the three-, five- and ten-year periods, which are called definitive cures or survival without recurrence, two-thirds are dead in three years, three-fourths in five years, and four-fifths by ten years, and, in the end, very few are left. Doctor Glenn's two patients fall within the group of patients with cancer of the stomach, technically resectable, without metastasis to the lymph nodes, in which Balfour showed 52 per cent survival at the end of five years.

Dr. J. William Hinton (New York) felt that Doctor Pack was rather optimistic, and based his opinion on the fact that, recently, when reviewing over 444 cases of cancer of the stomach, admitted to Bellevue Hospital in 20 years, he had noted two amazing findings. One was that operability does not vary with duration of symptoms. In other words, patients with cancer of the stomach, with symptoms of one month's duration, have no better chance than those with symptoms existing for one year. That, of course, goes back to the question of degree of rapidity of growth of cancer. The other discovery was that the true incidence of resectability of cancer of the stomach is far lower than is generally appreciated. For the physician who sends one favorable case to a special clinic, he has one or two he never sends to anyone, and these cases are never reported. Of the 444 cases admitted to Bellevue in 20

years, approximately 5.5 per cent were resectable. Two-thirds of those seen were inoperable and, of these, 50 per cent died while on the medical ward within a very short period of time after admission.

Dr. Sigmund Mage (New York) summarized the experience to date with radical surgery of carcinoma of the stomach at Mt. Sinai Hospital, and said that it bore out, almost exactly, the statistics presented by Doctor Pack. Only 40 per cent of the cases come to exploration, and only 35 per cent of those explored are found to be resectable. Cases have been followed at Mt. Sinai Hospital since 1922. One hundred thirty-nine resections were performed between 1922 and 1934, inclusive, the period during which there may have been a five-year, or longer, survival. Fifty-three deaths occurred in the 139 radical resections, or an operative mortality of 26 per cent. There were 86 operative survivals. Seventy-nine of these patients have been followed; seven were lost to follow-up. Sixty-five of the 79 died from recurrence of their disease; 61 died within five years. Four lived beyond the five-year period; as follows: One for 79 months; one for 87 months; one for 108 months; and one for 13 years. Three of these latter four cases are known to have died from recurrent carcinoma. Fourteen cases have been followed five years or longer, and of these, 12 remain under observation. Two were lost sight of within the past two years, one having been alive for five years and the other for nine years after operation. At present, one patient is alive 17 years after operation; one, 15 years; one, 14 years; three, ten years; two, nine years; one, seven years; and three, five years after operation. The patient living 17 years, and two of those living ten years after operation had nodular involvement. This group of five-year, or longer, survivals actually represents 17 per cent of the cases who survived radical resection.

As Doctor Pack has brought out, the experience at Mt. Sinai Hospital indicates that of every 100 patients entering Mt. Sinai Hospital to-day with carcinoma of the stomach, 60 will be found to be hopelessly inoperable; 40 will come to operation, and of these 26 will be found to be inoperable and 14 resectable. Of the 14 resectable cases, four will die as a result of the operation. Of the ten survivors, eight will be dead before five years, leaving just two patients of the original 100 with the prospect of living five years or longer.

GUNSHOT WOUND THROUGH THE ABDOMINAL AORTA

CASE REPORT

BORRIS A. KORNBLITH, M.D.

NEW YORK, N. Y.

FROM THE SURGICAL SERVICE OF DR. FRANK J. MC GOWAN, GOUVERNEUR HOSPITAL, NEW YORK, N. Y.

REPORT of the appended case seems worthy of record because the patient was still alive nine days after he sustained an apparently fatal wound.

Case Report.—Hosp. No. 41826: J. R., white, male, age 39, was admitted to the Gouverneur Hospital, August 12, 1939, with a history of having been shot, ten minutes previously, while bending over and facing his assailant.

Physical Examination.—The patient was pale, and in moderate shock. Blood pressure 100/65; the pulse ranged between 130 and 140. The wound of entry was found just to the right of the xiphoid cartilage. There was no wound of exit. The entire upper abdomen was held involuntarily rigid. There was no obliteration of liver dulness, and there was no evidence of any intrathoracic injury. The trachea was in the midline. The heart was not shifted. There was no change in the breath sounds. A roentgenogram of the abdomen showed the shadow of the bullet in the region of the second lumbar vertebra just to the left of the midline.

Operation.—An intravenous infusion of 1,000 cc. of 5 per cent glucose in saline was administered preoperatively, and a transfusion of 1,000 cc. of blood was begun at the same time as the exploratory celiotomy was undertaken. The procedure was begun one and one-half hours after the injury had been sustained.

Under gas-oxygen-ether anesthesia a 21-cm. right rectus muscle splitting incision was made. The peritoneal cavity contained about 1,000 cc. of fresh blood but no free air. There was active bleeding from a 4-cm. laceration in the superior surface of the left lobe of the liver. Another laceration, which bled freely, was present on the under surface of the left lobe of the liver. The further course of the bullet was found to be as follows: A small hole was present in the gastrohepatic ligament; another similar hole in the transverse mesocolon—after the bullet had traversed the lesser sac. When the great omentum and transverse colon were reflected cephalad, a small, ½-cm., subserosal hematoma was seen just touching the superior border of the transverse portion of the duodenum as it crossed the aorta. This small tear was closed by a single suture. A very thorough exploration of all the hollow viscera revealed no perforation (Fig. 1 A and B). It was possible to suture both lacerations in the liver and thus control the bleeding. A Penrose drain and one strip of packing were placed to the under surface of the liver. The abdomen was closed in layers. Time of operation was one and one-half hours.

Postoperative Course.—The immediate postoperative condition was good. The pulse became reduced to 110 per minute, and the blood pressure rose to 134/90. Glucose and saline intravenously and additional transfusions were administered during the succeeding days. The temperature ranged between 100° to 102° F. Colonic irrigations controlled the abdominal distention, and a Levin tube was employed repeatedly to relieve gastric retention.

On the fourth postoperative day, he developed a moderate jaundice. Bile was present in the urine. On the fifth postoperative day signs of pulmonary congestion began to appear in both lower lobes. After his general condition had been relatively good for six postoperative days the patient began to lose ground, and died on the ninth day.

Submitted for publication November 27, 1939.

Autopsy.—Path. No. 4734 (Medical Examiner) : Dr. B. M. Vance: The sclerae and the skin were jaundiced. The bullet wound of entrance measured 4 Mm. in diameter, with a rather slight zone of abrasion around it. It was located practically in the midline just below the xiphoid cartilage. The bullet passed through the left lobe of the liver at about the middle of its superior surface, and coursed backward before emerging. The bullet holes of entrance and exit had been sutured. There were a number of traumatic infarcts present about the bullet opening. The bullet then passed downward and back-

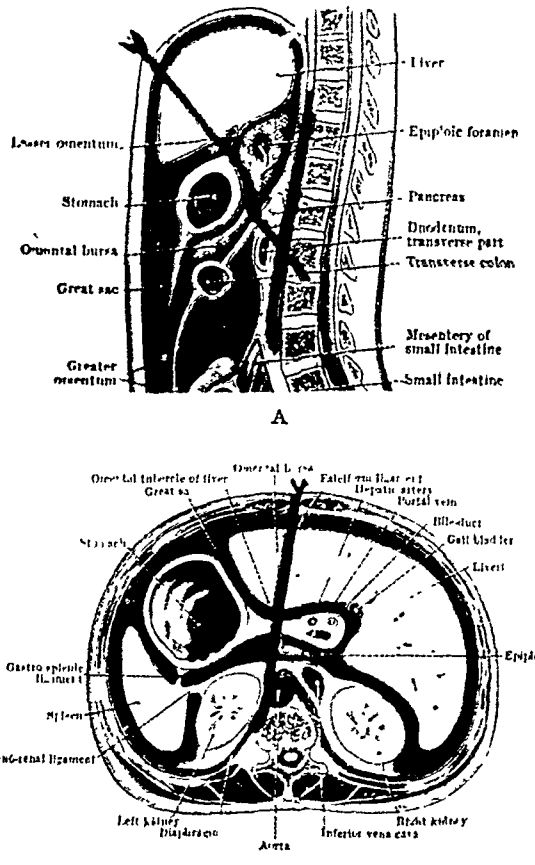
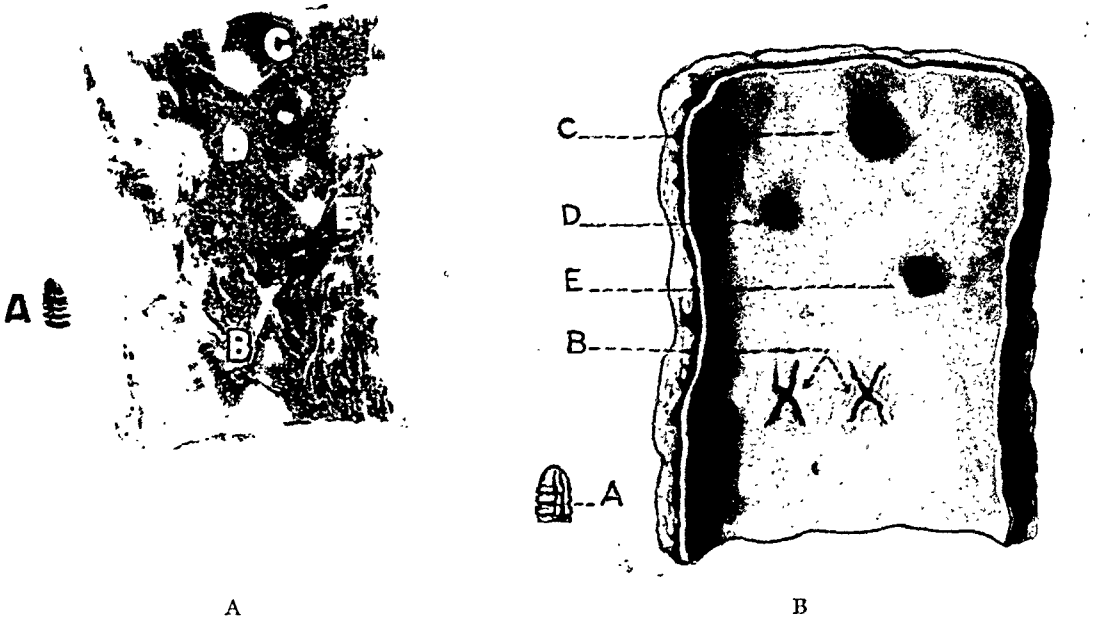


FIG. 1.—A and B: Diagrams in sagittal and longitudinal section showing the path of the bullet: Skin at xiphoid cartilage, rectus abdominis, fascia and muscle, parietal peritoneum, superior surface of the liver, left lobe of the liver, gastrohepatic ligament, the lesser sac, transverse mesocolon, superior border of transverse portion of the duodenum, abdominal aorta, and the body of the second lumbar vertebra. (Diagrams from Cunningham's Text-Book of Anatomy, Revised 4th Ed., p. 1235 and 1239, 1916. William Wood and Co., Baltimore.)

ward causing "binocular" openings in the abdominal aorta on its left side. These openings were stellate in shape, and were placed side by side in the same transverse plane about 15 Mm. apart. The lacerations measured 15 Mm. in length and 6 Mm. transversely. The bullet was recovered from the body of the second lumbar vertebra immediately behind the openings described above. The bullet was a .22 caliber, lead one (Fig. 2 A and B). There was a suture coapting a small rent located at the third portion of the duodenum near the jejunum. Except for local reaction about the operative site there was no evidence of peritonitis. Both lungs showed marked edema and hypostatic bronchopneumonia. *Pathologic Diagnosis:* Bullet wound of abdomen, liver, aorta and second lumbar vertebra; hypostatic bronchopneumonia.

Discussion.—In both civil life and during war, gunshot injuries of the aorta have, apparently, been uncommon. The extensive reports of the last war

do not cite any cases which came to operation (Wallace[1]). A search of the literature yielded only two cases that are pertinent. Brentano[2] reports the case of an infantryman who lived for 70 days after a "binocular" gunshot wound through the abdominal aorta near the renal arteries. The soldier, injured during a battle in the Russo-Japanese war, died because of a perito-



A B

FIG. 2.—A and B: Photograph of gross specimen and descriptive drawing of the segment of aorta in the region of the first and second lumbar vertebrae. (A) .22 caliber lead bullet. (B) Gunshot lacerations of the aorta. (C) Superior mesenteric artery. (D) and (E) Renal arteries.

nitis and an infected hematoma in the right lumbar gutter. At a postmortem examination the perforations in the aorta were discovered. A photograph of these perforations is very similar to those shown in Fig 2 A and B of the case herewith reported. The hematoma originated from a laceration of the liver caused by the bullet passing through it. There was no thrombus in the aorta nor any evident bleeding about the site of the perforation in it. Fibrin blocked the efflux of any blood from the vessel. There was no sign of aneurysm formation at the end of 70 days, although Brentano states that he had seen aneurysm formation much earlier resulting from tangential injuries of smaller vessels.

The fact that a through-and-through injury of the aorta tends to close over, is illustrated by the remarkable case of Edmundson.[3] An African native walked into the hospital with a "pulsating" arrow protruding from his anterior chest wall. He had been shot at close range, 13 hours previously. The patient died on the operating table when the point of the arrow was withdrawn from the ascending portion of the aorta. The point of the arrow had transfixed the vessel, but caused no hemorrhage until the attempt at removal was made.

The case reported herewith and the two cited above illustrate that injuries of the aorta with preservation of continuity of the vessel may repair them-

selves and are not necessarily fatal. However, when a large vessel is injured it is generally accompanied by such extensive damage to intervening soft parts in transit that the patient either dies immediately or very soon afterward, as a result of the complicating injuries.

In the present instance, there was no peritonitis or injury to any hollow viscus. The patient died of a complicating hypostatic bronchopneumonia. This pulmonary complication may be attributed to the length of time the exploratory celiotomy consumed, and to the initial shock that the patient suffered. The initial shock, however, may have saved his life for the time being.

The perforation of the aorta in two of the three cases here cited must be classified as "lesions overlooked" since they were not discovered until the postmortem examination. However, according to one series of 164 cases of perforating wounds of the abdomen, reported by McGowan,[4] the lesions overlooked constituted nine per cent, or 15 cases. A thorough exploratory celiotomy is thus apparently of greater importance than speed in completing the operative procedure.

SUMMARY.—(1) A case of bullet wound of the abdomen involving the left lobe of the liver and the abdominal aorta is reported.

(2) The patient lived for nine days, and died of a complicating hypostatic bronchopneumonia.

(3) Two additional cases are cited from the literature.

REFERENCES

[1] Wallace, Cuthbert: A Study of 12,000 Cases of Gunshot Wounds of the Abdomen. Brit. Jour. Surg., 4, 679, 1916.

[2] Brentano, A.: Über Gefassschusse und Ihre Behandlung. Arch. f. klin. Chir., 80, 394, 1906.

[3] Edmundson, E.: Transfixion of the Aorta (by Arrow). Brit. Jour. Surg., 23, 869, 1936.

[4] McGowan, Frank J.: Penetrating Wounds of the Abdomen. ANNALS OF SURGERY, 162, 395, 1935.

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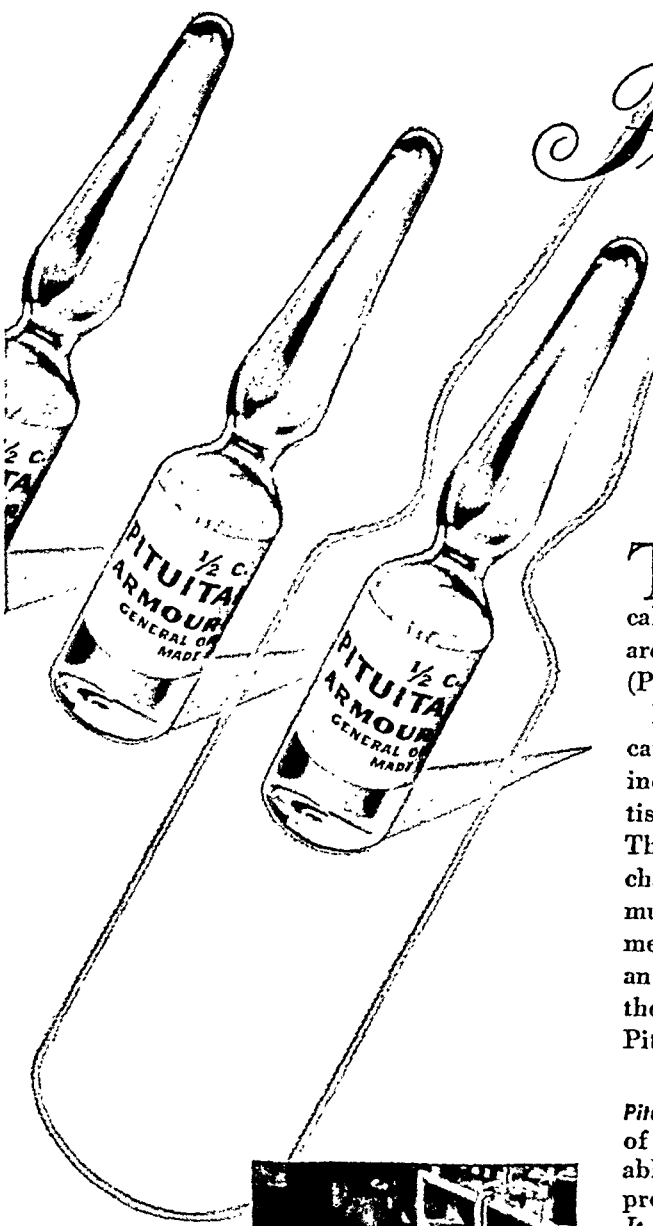
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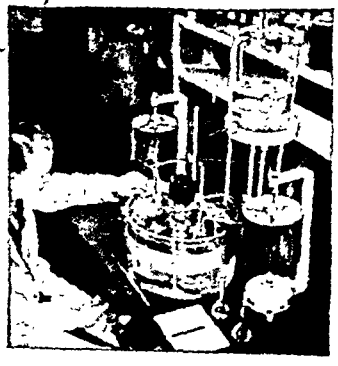
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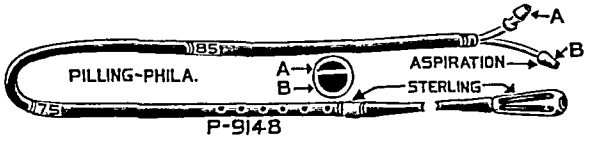
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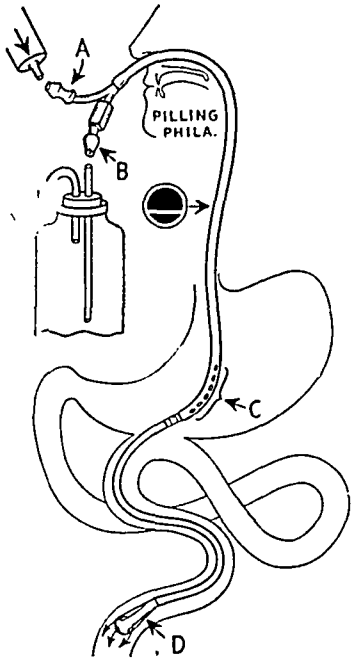
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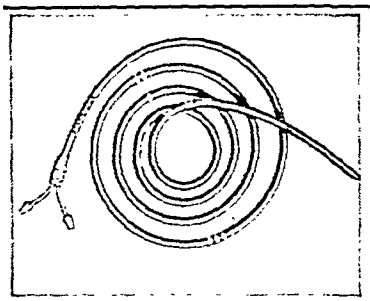
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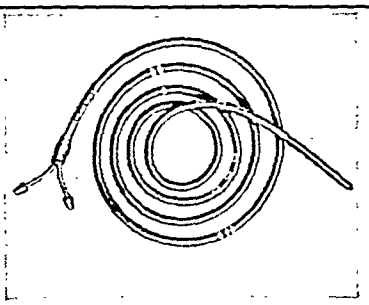


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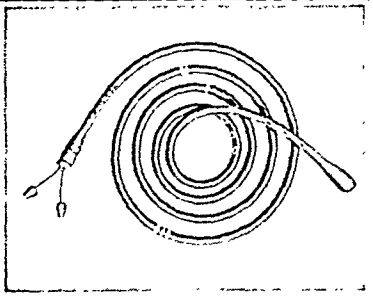
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CONTENTS

Vol. 113 MAY, 1941 No. 5

ADDRESS OF THE PRESIDENT: THE STORY OF PLASTIC SURGERY — John Staige Davis, M.D., Baltimore, Md. 641

SYMPOSIUM ON WAR INJURIES

BLOOD AND BLOOD SUBSTITUTES IN THE TREATMENT AND PREVENTION OF SHOCK: WITH PARTICULAR REFERENCE TO THEIR USES IN WARFARE — Alfred Blalock, M.D., M. F. Mason, Ph.D., Nashville, Tenn. 657

PERIPHERAL VASCULAR INJURIES — I. A. Bigger, M.D., Richmond, Va. 677

UROGENITAL INJURIES — Parke G. Smith, M.D., Cincinnati, Ohio 685

NJURIES OF THE CHEST — Daniel C. Elkin, M.D., M. H. Harris, M.D., Atlanta, Ga. 688

THE RÔLE OF THE PLASTIC SURGEON IN THE CARE OF WAR INJURIES — Vilray P. Blair, M.D., St. Louis, Mo. 697

NEW DEVELOPMENTS IN THE TREATMENT OF COMPOUND FRACTURES — Guy A. Caldwell, M.D., New Orleans, La. 705

WAR WOUNDS OF THE NERVOUS SYSTEM — Claude C. Coleman, M.D., Richmond, Va. 712

ABDOMINAL INJURIES — Ambrose H. Storck, M.D., New Orleans, La. 720

AIDS IN AVOIDING SERIOUS COMPLICATIONS IN THYROIDECTOMY — Frank H. Lahey, M.D., Boston, Mass. 730

PRECAUTIONS IN THE TREATMENT OF THYROTOXICOSIS — Warren H. Cole, M.D., Chicago, Ill. 752

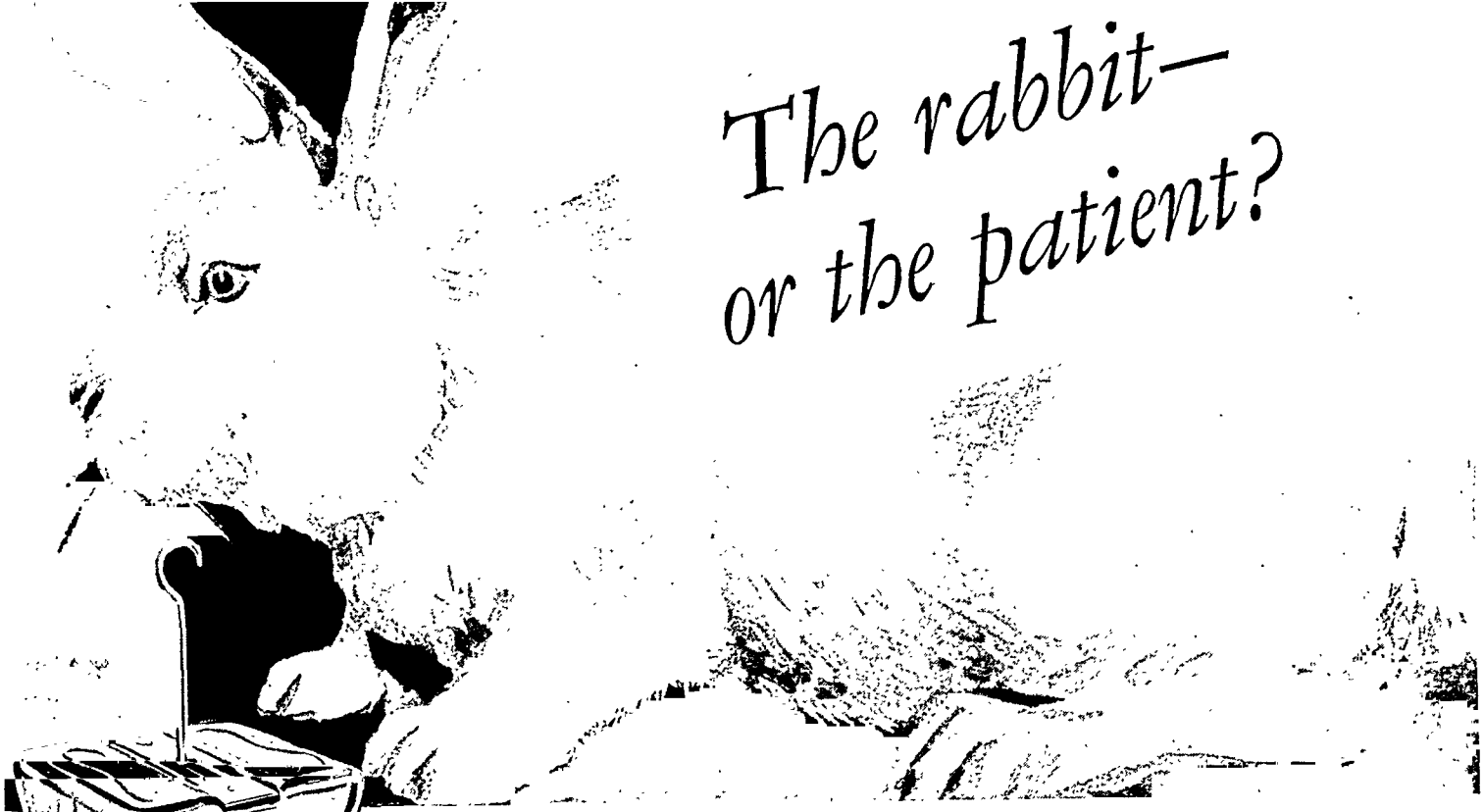
MEDIASTINAL GANGLIONEUROMA — Arthur G. James, M.D., George M. Curtis, M.D., Columbus, Ohio 767

ENDOCRINE STUDIES OF PATIENTS AFTER SUBTOTAL HYPOPHYSECTOMY — Paul Starr, M.D., Loyal Davis, M.D., Chicago, Ill. 778

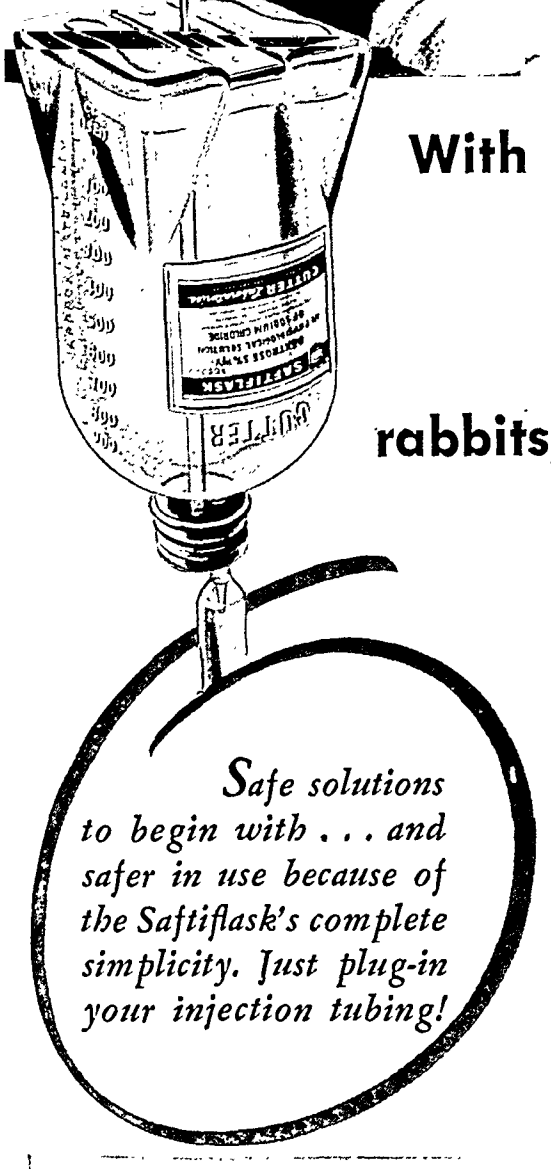
PERFORATED PEPTIC ULCER — R. Arnold Griswold, M.D., Louisville, Ky., Rudolph F. Antoncic, M.D., Cleveland, Ohio 791

RESECTION OF THE DUODENUM FOR TUMOR OF THE AMPULLA OF VATER — J. Shelton Horsley, M.D., Richmond, Va. 802

(Contents continued on page 4)



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SECONDARY OPERATION ON THE BILIARY SYSTEM Harold L. Foss, M.D.
John Lillie, M.D.
Danville, Pa. 810

ACUTE CHOLECYSTITIS WITH PERFORATION INTO THE PERITONEAL CAVITY C. R. Edwards, M.D.
W. H. Gerwig, M.D.
W. L. Guyton, M.D.
Baltimore, Md. 824

A METHOD OF HANDLING THE APPENDIX STUMP — Alfred P. Jones, M.D.
Roanoke, Va. 833

END-RESULTS IN REPAIR OF INGUINAL HERNIA BY A FASCIA-TO-FASCIA RECTUS SHEATH CLOSURE William L. Estes, Jr., M.D.
Bethlehem, Pa. 838

THE MANAGEMENT OF BILATERAL RENAL STONES J. Garland Sherrill, M.D.
D. P. Hall, M.D., M.S.
Louisville, Ky. 851

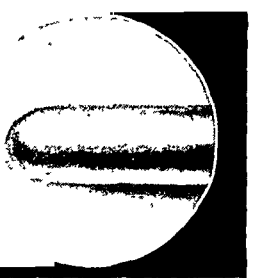
AIR PYELOGRAPHY Owsley Grant, M.D.
Robert Lick, Jr., M.D.
Louisville, Ky. 865

THE SURGICAL TREATMENT OF ARTHRITIS Frank D. Dickson, M.D.
Kansas City, Mo. 869

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SPONTANEOUS RUPTURE OF THE COMMON BILE DUCT E. Dunbar Newell, M.D.
Chattanooga, Tenn. 877

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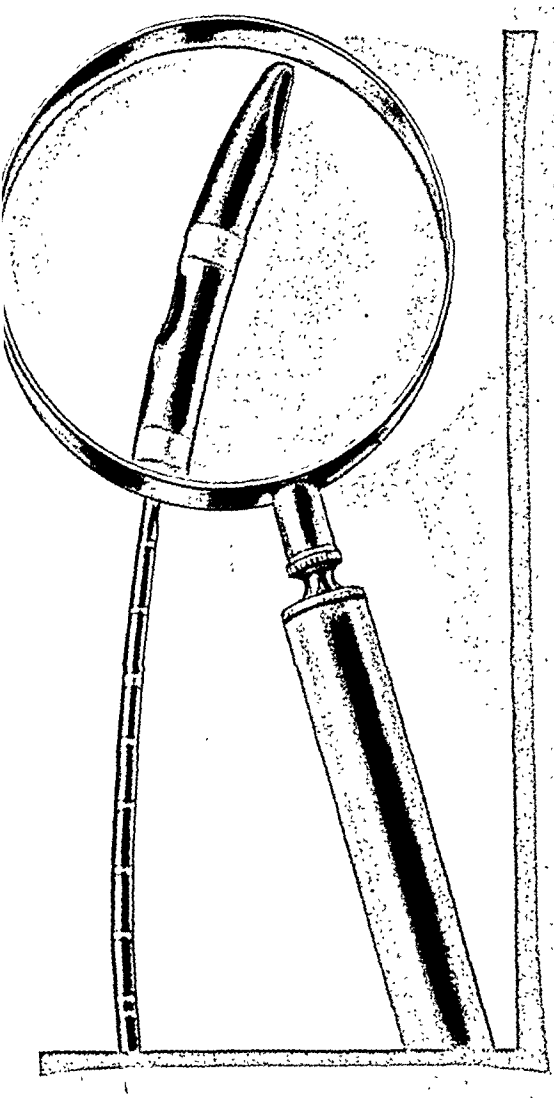
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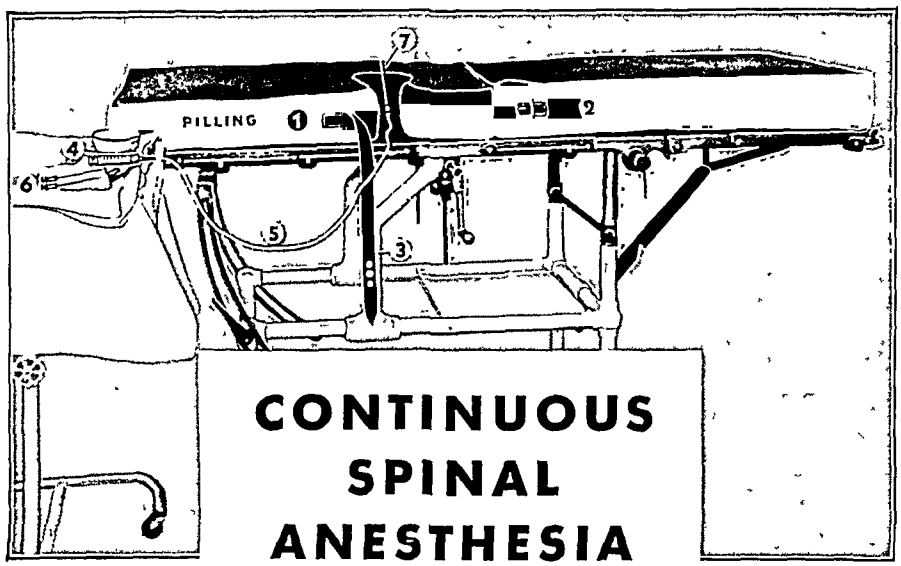
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Austenal Laboratories, Inc. . . . 27
Rudolph Beaver . . . 28
Wilmot Castle Company . . . 8
Clay-Adams . . . 20
Cutter Laboratories . . . 3
V. Mueller & Co. . . . 18
George P. Pilling & Son Co. . . . 6, 22
Prometheus Electric Corporation . . . 27

LIGATURES

Davis & Geck, Inc. . . . Insert, 8-9, 16
C. De Witt Lukens Co. . . . 16
Deknatel . . . 23
Johnson & Johnson . . . 15

PHARMACEUTICAL SUPPLIES

Anglo-French Drug Co., Inc. . . . Inside Front Cover
Armour & Company . . . 14
Bilhuber-Knoll Corporation . . . 22
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C. V. Mosby Company . . . 26

X-RAY APPARATUS AND SUPPLIES

General Electric X-ray Corporation . . . 19
Patterson Screen Company . . . 11
Radium Emanation Corporation . . . 4



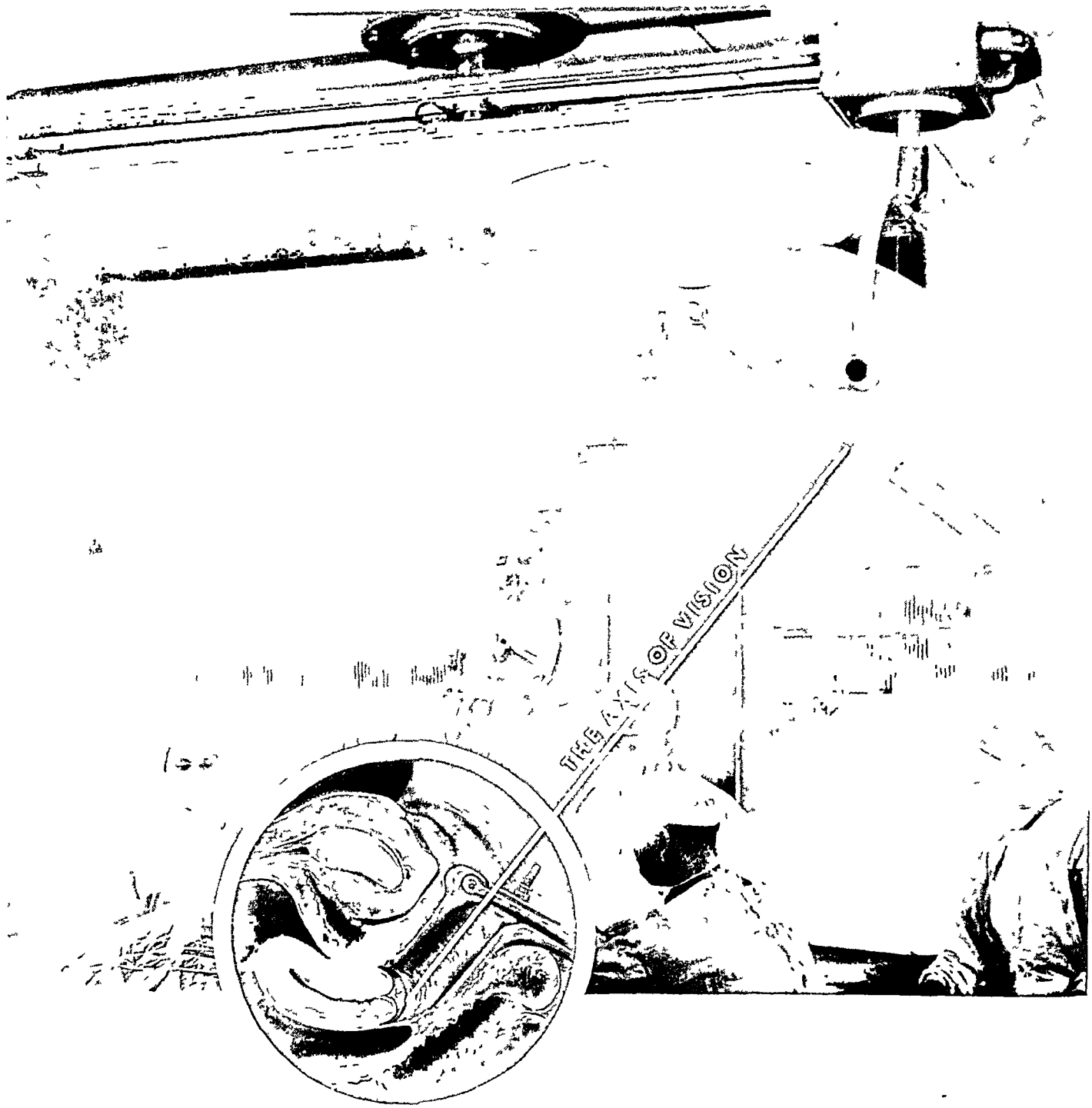
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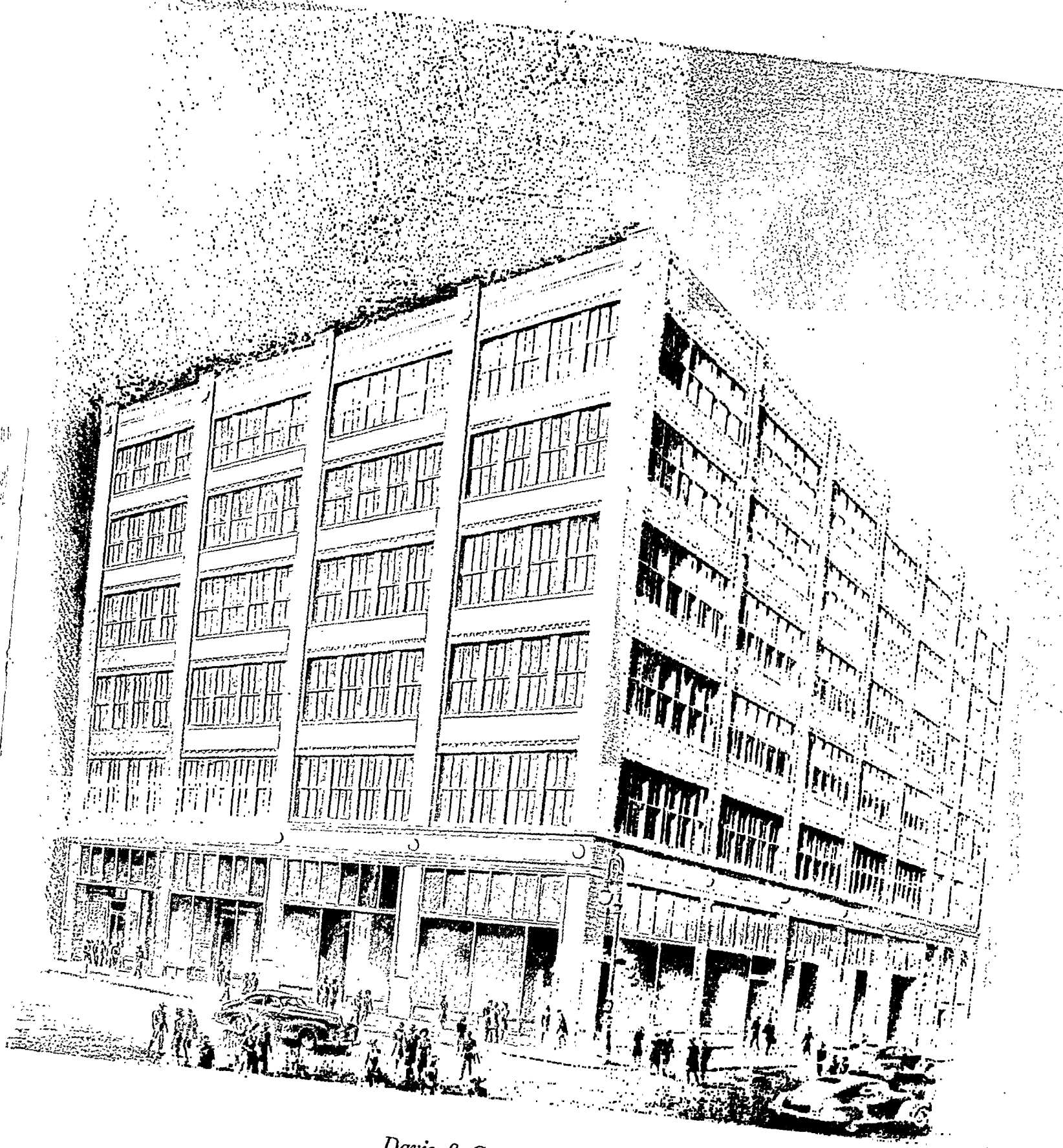
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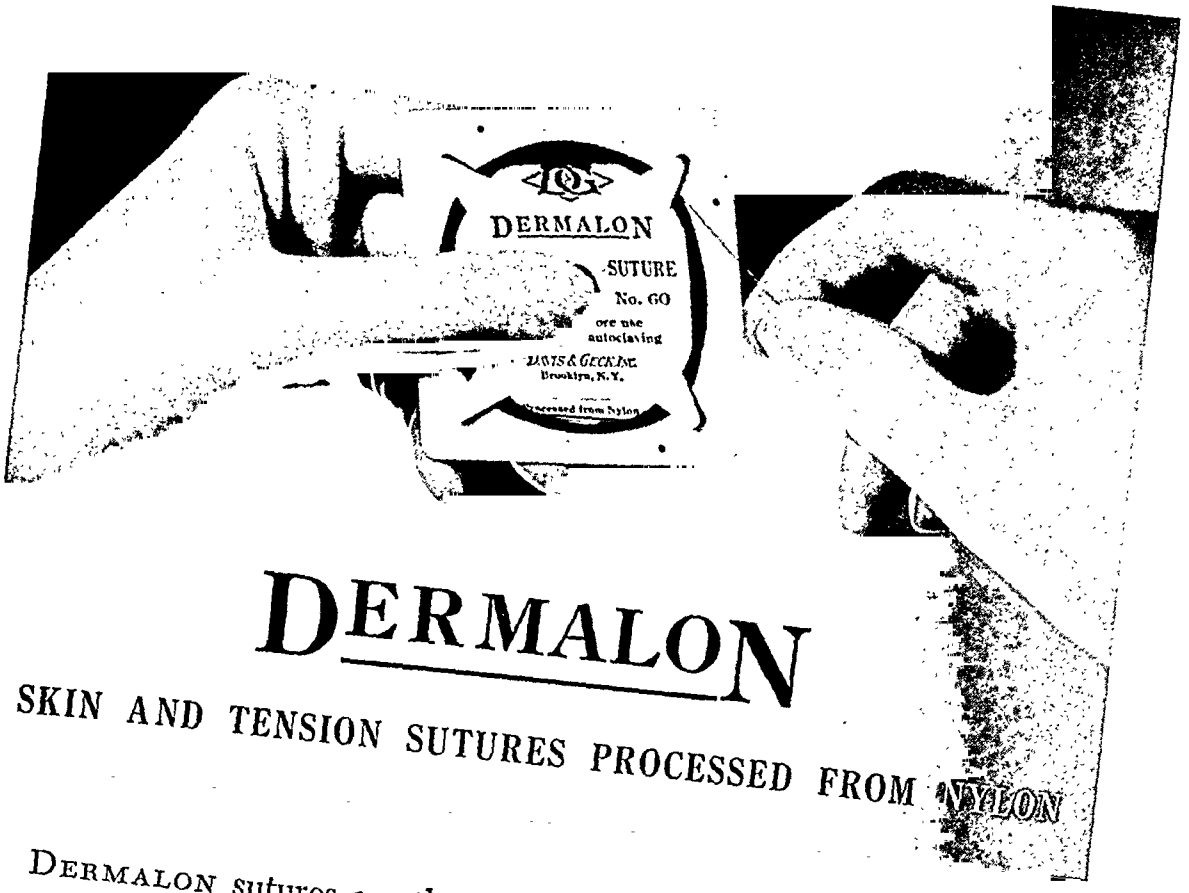
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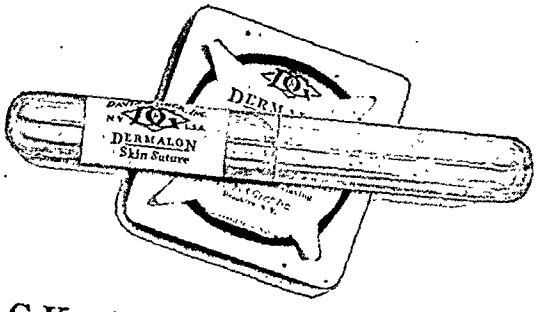


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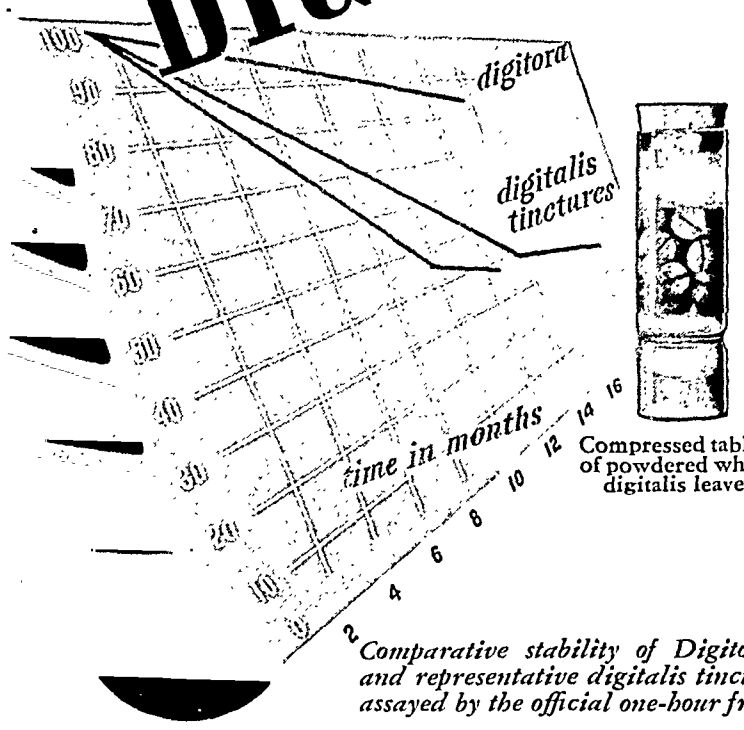
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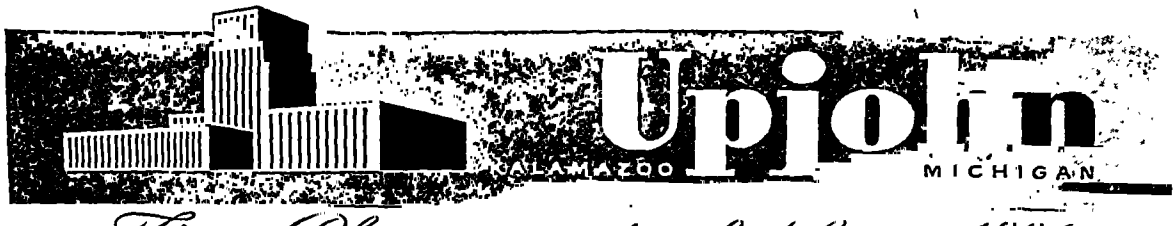
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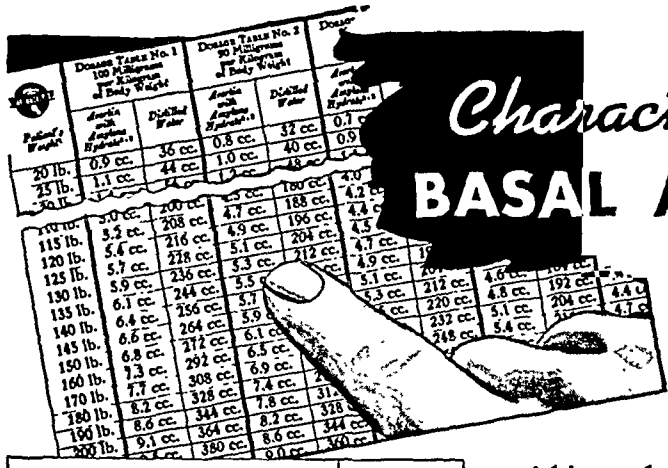
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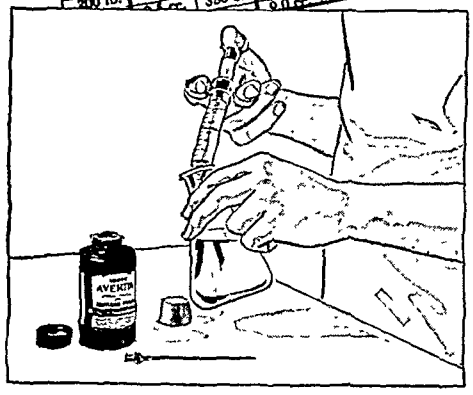
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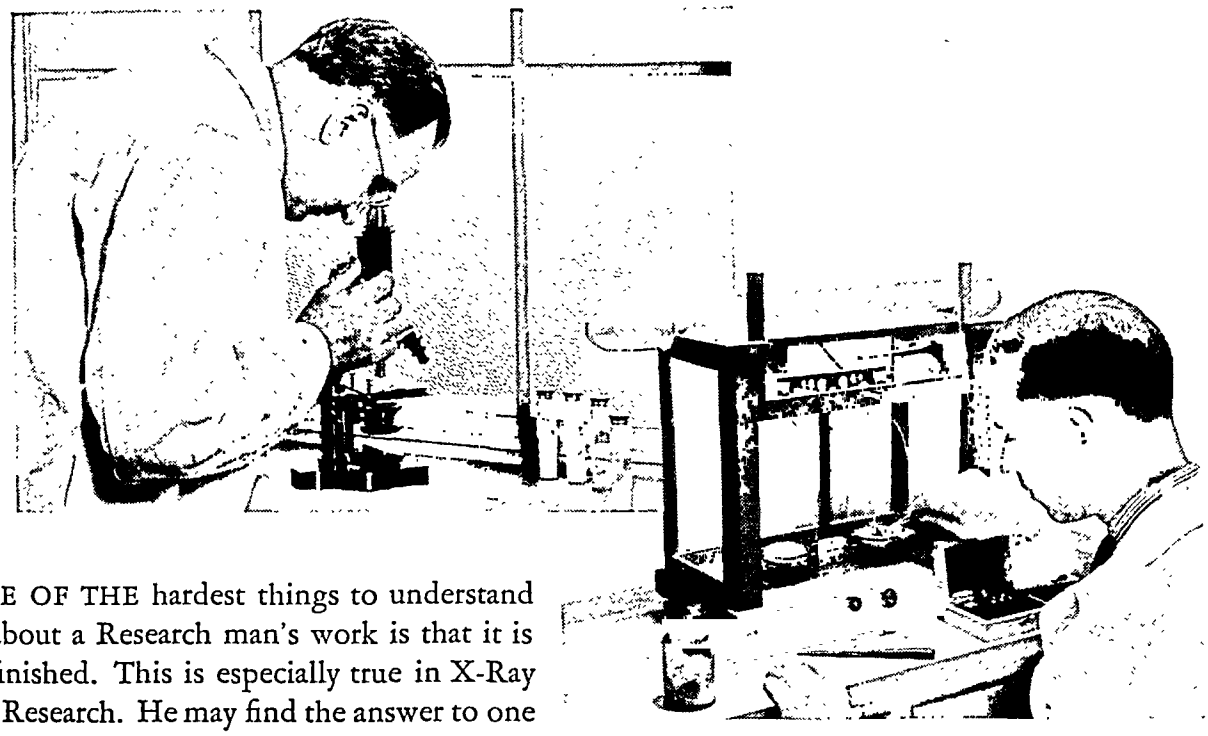
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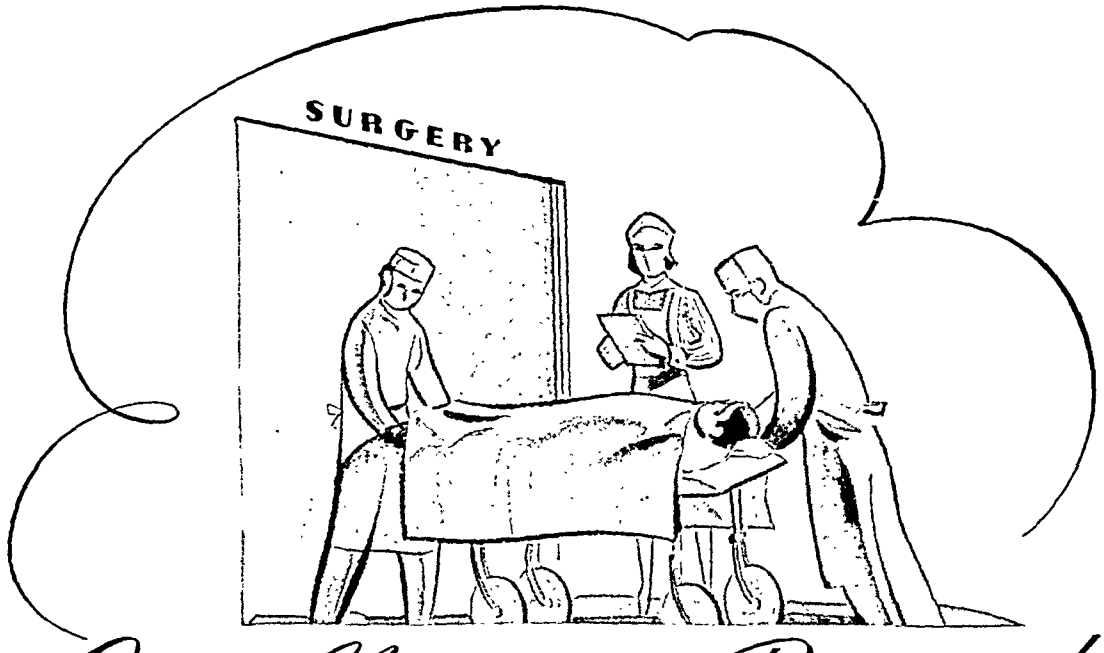
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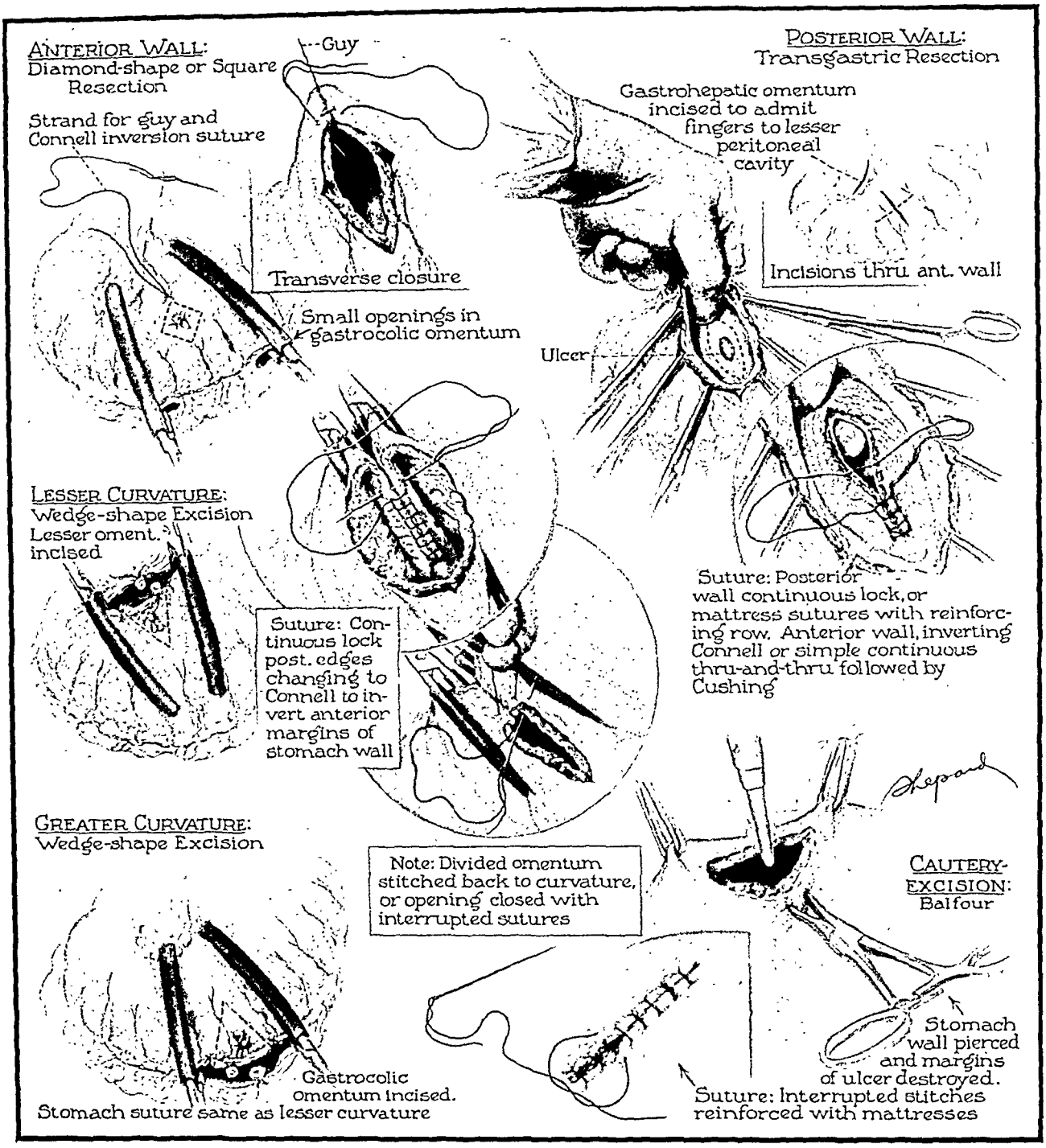
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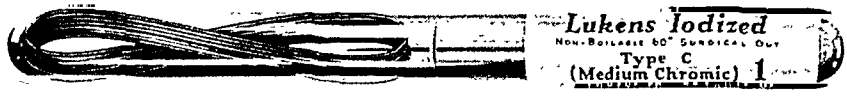
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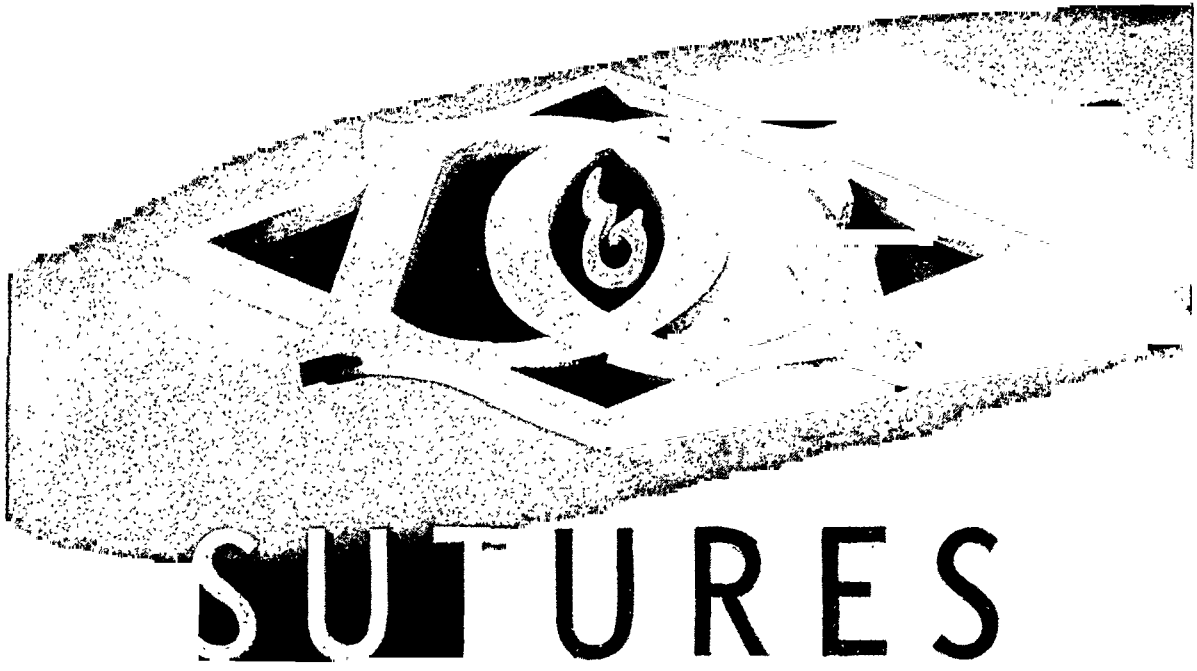
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ANNALS OF SURGERY

VOL. 113 MAY, 1941 No. 5

TRANSACTIONS

OF THE

SOUTHERN SURGICAL ASSOCIATION

MEETING HELD AT HOT SPRINGS, VA.

DECEMBER 10, 11, 12, 1940

ADDRESS OF THE PRESIDENT

THE STORY OF PLASTIC SURGERY*

JOHN STAIGE DAVIS, M.D.

BALTIMORE, MD.

IN LOOKING ABOUT for a theme, which had not been considered in any Presidential Address in the more than half century of the life of this Association, I have chosen the story of plastic surgery.

In the limited time at my disposal, and because of the immensity of the subject, it will be impossible to even name more than a very few of those who have evolved the basic principles upon which modern plastic surgery is built, and who have set the milestones on the road, which all of us strive to follow. It is more than likely, also, that in the journey through the centuries which we are about to take, that some of the milestones themselves, may have been missed.

As far as I can ascertain, the oldest specialty is midwifery, the next in age is ophthalmology, and the records seem to show that plastic surgery is equally as old as ophthalmology.

From ancient times up to the seventeenth century, the care of wounds caused by war, which was almost as chronic a state then as in these enlightened modern days, was a great incentive toward the development of surgery. Many of the disfigurements of noses, ears, lips, *etc.*, caused by war

* Presented before the Fifty-third Annual Session of the Southern Surgical Association, Hot Springs, Va., December 11, 1940.

injuries, as well as by punishments for infidelity, thievery and other misdemeanors, stimulated the evolution of methods of plastic repair.

The history of plastic surgery through the ages is closely associated with operations for nasal reconstruction, and many of the principles evolved and general procedures employed in plastic surgery to-day, have been developed in this type of reconstructive work.

Who coined the term "Plastic Surgery"? The title of Eduard Zeis' (1807–1868) book, published in 1838, was Handbuch der Plastischen Chirurgie, and he says: "As far as I know I was the first to use the words 'plastic surgery.'" The vastness of the literature on plastic surgery may be grasped when we realize that in his second book Die Literatur und Geschichte der Plastischen Chirurgie, published in 1863, Zeis collected the titles of over 2,000 articles on subjects dealing with plastic surgery, from the earliest times up to 1859. Since that time, during the last 80 years, many contributions to the subject have appeared, which, without doubt, more than equal in number the figures previously presented by Zeis.

What do we mean by plastic surgery? Its *science* is the organized knowledge of the fundamental principles involved in the transplantation and shifting of tissues, with a clear understanding of what can be accomplished by this work. Its *art* is the application of this knowledge and the actual manipulative reconstruction. Its *field* extends from the top of the head to the soles of the feet.

Plastic surgery is primarily that branch of general surgery which is distinctly formative or constructive. It deals with the repair of defects and malformations, either congenital or acquired; with the restoration of function and comfort; and incidentally with improvement of appearance, and consequent relief of certain psychoses due to consciousness of deformity. This is accomplished chiefly by readjustment of tissues or by the transfer of all types of transplantable tissues, either from the immediate neighborhood or from some distant location.

The deformities dealt with in plastic surgery, for the most part, involve the skin or adjacent soft parts of the entire body, but frequently the framework of bone or cartilage underlying the soft parts must also be reconstructed or readjusted. The treatment of large denuded surfaces, and of intractable wounds of all types, which require skin grafting or flap-shifting also belong in the field of plastic surgery.

There is another aspect of the subject, which may be called esthetic plastic surgery, and this deals with the correction of imperfections in human proportions, both real and fancied, and has as its primary object the restoration of symmetry of contour and improvement of appearance. There are well-trained and ethical surgeons who specialize in this aspect of plastic surgery,

The speaker illustrated his address by two groups of lantern slides: The first group showed the likenesses of a few of the men famous in the development of plastic surgery. The second group showed some of the types of cases which the plastic surgeon, in civil life, is called upon to treat.

but it must be understood that this is also the happy hunting ground of the charlatan and the quack.

From every standpoint, I believe that better results can be obtained by having plastic surgery a subdivision of general surgery, connected with great teaching hospitals, rather than have it, even if large endowments are available, as disconnected separate units or institutes without such connections. This is true both from the standpoint of the care of the patient and also from that of instruction and research, as it is essential to have the help and cooperation of the various preclinical and clinical departments as well as the dental, medical art, and laboratory divisions. The help of all these departments is frequently sought and is invaluable. It has been my experience that the Division of Plastic Surgery is used by practically every clinical department, both medical, surgical and dental at one time or another, so the cooperation is mutually beneficial.

Proficiency in plastic surgery demands the same familiarity with the fundamental medical sciences and the same application of surgical principles as is essential in any type of surgery with, in addition, a refinement of technic, a sense of geometric proportions, and an artistry not commonly called for in the execution of most surgical therapeutic procedures.

Strange as it may seem, even in 1940, when plastic surgery is spoken of, I venture to say that the majority of the medical profession immediately think of its esthetic aspect only and entirely forget the major reconstruction work by which human wrecks are restored to usefulness, both physically and mentally, and are enabled to again earn a living.

Some other misconceptions about the subject are that plastic surgery is confined to constructive work on the face; that it consists of skin grafting only; that it was entirely a development of the First World War (1914–1918); and that nothing of importance had ever been previously undertaken in plastic and reconstructive work. Unquestionably, the World War awakened general interest in the possibilities of the subject, but few additions were made to the basic principles of plastic surgery, which had been established long before. However, the large number of cases available made it possible to eliminate unsound procedures and to standardize and improve operative measures, particularly in certain groups of facial injuries.

It was my belief until recently that rhinoplasty and other plastic operations on ears, lips, *etc.*, were described in the ancient Egyptian writings. In the Edwin Smith Papyrus, probably copied about 1600 B.C., injuries to the nose and its framework as well as wounds of the ear, upper lip and chin are reported, and methods of surgical treatment are given, but in the translation of this and other *papyri* and in other early records, I can find no mention of definite plastic procedures.* Galen suggests that the Egyptians were well-acquainted with plastic procedures but they did not pass on their knowledge to others.

* It is estimated that the original source, from which the Edwin Smith Papyrus was copied, was written between 3000 and 2500 B.C.

As far as I can ascertain, the earliest real plastic surgery was done by the Hindoos, and knowledge of the methods employed by them was carried by students and itinerant surgeons to Egypt, Greece and Arabia, and subsequently to the other Mediterranean countries.

The early Hindoo surgeons were required to undergo a long period of preliminary training, and the importance of a knowledge of anatomy was stressed. They developed great dexterity, and they excelled all other nations of their time in operative surgery. They were especially skilled in skin-shifting and other phases of reconstructive work. Sushruta, who was the father of Hindoo surgery, wrote his original Samhitá about 750–800 B.C., and this is based on the four sacred Vedas, which were written many years earlier.

Sushruta writes in detail of an operation for the reconstruction of a lost nose by the advancement of a cheek-flap, and this is the oldest known description of rhinoplasty. He also describes plastic operations for the repair of lips by means of cheek flaps, and also 15 methods of repairing split or mutilated lobes of ears. This method of utilizing sliding flaps was called, many centuries later, the French method.

Hindoo surgery began its gradual decline from the time of Buddha (562–552 to 482–472 B.C.). He and his followers gave great support to medicine, but all opportunity for surgical advance by animal experimentation, *etc.*, was suppressed, as contacts with blood, pus and diseased tissues which were necessary in surgery were considered polluting. In time, the fundamental truths on which surgery had been based were lost and surgical practice was turned over to the lowest castes who were considered so unclean that they could not be further contaminated by doing surgical work.

These plastic operations in India, which the physicians did not condescend to perform, were delegated to certain members of the Koomá or Tilemaker caste, and the art was passed down from father to son.

The writings of Hippocrates, the Great (460–370 B.C.) and Aristotle (384–322 B.C.) contain no reference to skin-shifting or to plastic surgery. However, plastic procedures were apparently well-known in Rome at the beginning of, and during the first few centuries of the Christian era.

Aulus (Aurelius) Cornelius Celsus, who may well be called the Father of plastic surgery, was born in Rome about the time of the birth of Christ and died about A.D. 50. In the year A.D. 30, he wrote a book De Re Medica which is remarkable for its completeness and accuracy, and it is the oldest medical document after the writings of Hippocrates. In this book, in addition to other things, he described different plastic operations, among them the first operative treatment for ectropion, ptosis and entropion of the eyelids. He told how to repair with skin flaps from adjacent areas, mutilated ears, noses and lips where the loss of tissue was small. Although his knowledge of plastic procedures was undoubtedly derived from Hindoo sources, he does not mention the more extensive rhinoplastic operations performed by the Hindoos. He described an operation for the separation of fingers in

syndactylism; and a plastic operation on the penis to cover the glans with skin where circumcision had been too thoroughly done. He speaks of the treatment of lips accidentally torn or split, but I can find no mention of the treatment of congenital clefts of the lip.

The use of the ligature was described by Celsus in his seventh book, and was a well-known procedure in his period.

There are a number of reasons, which point to the fact that Celsus was simply a Roman gentleman with an intimate knowledge of medicine and that he was not a practicing physician. He was ignored by the Roman practitioners of his day, and Garrison says that his name is mentioned only four times by medieval commentators, in spite of his outstanding contributions. However, with the revival of learning, his book De Re Medica was one of the first medical books to be printed in 1487.

Antyllus, who lived in the first half of the second century A.D., described certain plastic operations, and his work is probably based on the writings of Celsus.

Claudius Galen (A.D. 131–201), greatest Greek physician after Hippocrates, was born in Pergamos, Asia Minor, and began to practice in Rome about A.D. 164. He was a most voluminous writer on philosophic and medical subjects, and his medical and surgical writings were for centuries the supreme authority in medical science. There was no appeal from what he wrote, and this point of view was maintained until the seventeenth century. The infallibility of Galen's theories and writings was first disputed by Leonardo da Vinci (1452–1519), and later by Andreas Vesalius (1514–1564), and others.

Galen described plastic methods for the repair of colobomata in the lips, ears, and alae of the nose with skin from adjacent areas, and many of his ideas on plastic procedures were very similar to those of Celsus, although Celsus was given no credit.

Oribasius (A.D. 325–403), describes the plastic operations of Galen and Antyllus, and Paul of Aegina (625–690) followed Galen's methods of treatment of nose and ear defects.

With Hippocrates and his followers, there was no distinction between medicine and surgery. However, Galen said, "surgery is only a mode of treatment," and in due time, following this as a lead, medicine was separated from surgery in about the seventh century. Avicenna (980–1037), the celebrated Arabian physician, treated the surgeon himself, as an inferior being. On the other hand, Lanfranc of Milan and Paris, who died in 1315, and others insisted that medicine and surgery should not be separated, and that a knowledge of medicine was as necessary to a surgeon as a scalpel. However, centuries were to pass and bitter controversies were to be waged between surgeons and barber surgeons, and between physicians and surgeons before medicine and surgery were placed on the same professional and social level.

Beginning with the time of St. Benedict, A.D. 525, many individuals re-

requiring medical and surgical treatment were taken care of in the monasteries by the monks, and, in time, the principle knowledge of medicine and surgery was to be found in the hands of the priesthood. From the ninth to the thirteenth century, the Jews shared with the clergy the monopoly in the healing art, having obtained their knowledge from the Arabs. With the exception of one or two meager descriptions of operations for the repair of congenital clefts of the lip and a few discussions as to whether noses which had been cut off could be replaced and would live, plastic procedures were apparently forgotten during this entire period.

In A.D. 1215, Pope Innocent III decreed that no priest, deacon or subdeacon should perform any surgical procedures, which involved bloodshed, as it was incompatible with the divine mission. As a result, such procedures were turned over to barbers, bathkeepers, executioners, mountebanks, sowgelders, and other individuals of low degree, much as had been done in India hundreds of years before.

About the middle of the fifteenth century, there lived in Catanea, Sicily, a family of the name of Branca, who came into prominence when it became known that they were able to reconstruct noses, which had been cut off, or had been destroyed by disease, and that they could also repair defects in ears and lips by utilizing flaps from the face or forehead.

It was also said that Branca could transplant successfully the nose of a slave to his master. Branca is thought to have been the first to use a flap from the arm to reconstruct a nose, but his son, Antonius, perfected the arm-flap operation, and to him belongs the credit of developing what is known as the Italian method. The earliest record of their work is found in the Annals of the World by Peter Ranzano, Bishop of Lucerne, in 1442.

A brief note found in a work on anatomy by Alexander Benedictus (1460–1525), published in Venice in 1497, describes how "a nose may be repaired by skilled persons by the use of an arm flap." Other surgeons, of more or less repute, were impressed with this work and various allusions, both favorable and derogatory, to the operation are to be found in surgical works of the sixteenth century.

In 1460, Heinrich von Pfolspeundt, a Bavarian army surgeon, wrote of the flap-from-the-arm method used by the Brancas for rhinoplastic restoration, and this was 126 years before it was described by Tagliacozzi. He obtained his knowledge of the method from individuals who had seen these rhinoplastic operations performed.

The use of the arm-flap in reconstructing a nose was mentioned by Gabriel Fallopius (1523–1562), Ambroïse Paré (1510–1590), and Andreas Vesalius (1514–1564), but, principally, in a critical or in a skeptical vein.

The first systematic treatise on plastic surgery ever written was published in 1597, by Gaspar Tagliacozzi (1546–1599), the Professor of Surgery at Bologna. It was entitled De Curtorum Chirurgia per Insitionem, and was a volume of 298 pages, including 22 full page plates. In it, he described various plastic operations on the lips and ears, but gives special prominence

to his method of rhinoplasty, in which he used a pedicled-flap from the arm, but he makes no mention of anyone having previously performed a similar operation. This operation was undoubtedly based on the procedures of the Brancas, but is commonly called the *Tagliacotian* or *Italian* method, as the operation was brought to public attention and was popularized by him. His first rhinoplasty was performed in 1580, on Conti Brachetti di Moderna, and his fame soon became widespread.

Tagliacozzi incurred the antagonism of the church, as his work was considered sacrilegious because he attempted to improve or undo God's handiwork. This religious persecution was carried on even after he had been buried, as his body was exhumed from consecrated ground in the Church of San Giovanni Battista and was buried elsewhere. All his books were called in by the church to be destroyed, but fortunately a number of them were saved and later editions published.

After the death of Tagliacozzi, several surgeons wrote of his methods, but in a few years Tagliacozzi's method was forgotten and soon became more of a legend than a reality, and, in the course of time, it began to be considered an impossibility.

Reneaulme de la Garanne (1712) tried to rehabilitate Tagliacozzi's arm-flap method of rhinoplasty, and proposed sewing the fresh flap into the defect, immediately after raising it, without waiting for it to granulate as was done by Tagliacozzi. This same idea was again suggested by von Graefe 100 years later.

The Indian method of rhinoplasty by means of a forehead flap was brought to the attention of European surgeons by a letter which was printed in the Gentleman's Magazine for October, 1794. It described in detail, with drawings, the reconstruction, by a member of the Tilemaker caste in India, of a nose which had been cut off. This operation had been observed by two medical men, Mr. Thomas Cruso and Mr. James Findlay, of Bombay, and was the type which had been practiced from time immemorial in India by members of this caste.

The first English surgeon to make use of this information was Joseph Constantine Carpue (1764–1846), of London. He successfully performed rhinoplasty by the Indian method in September, 1814, and again in January, 1815, and subsequently performed other operations of the same kind. Thus the possibility of the restoration of lost noses was again brought to public attention, although not by the Italian or Tagliacotian method.

The use of the Indian method was introduced into Germany by von Graefe, in 1816, and Dieffenbach, in 1829; into France by J. Lisfranc (1790–1847), in 1826; and into the United States by J. M. Warren, in 1834. Since that time, this type of rhinoplasty, with the forehead flap, has been performed many times, by many operators, and with many modifications.

Tagliacozzi's arm-flap method of rhinoplasty was revived by Carl Ferdinand v. Graefe of Berlin (1787–1840), and he reported one successful case.

In 1818, he published a book called Rhinoplastic, the first monograph on rebuilding noses to be written since that of Tagliacozzi, in 1597.

Johann Friederich Dieffenbach (1792–1847), of Königsberg, was a genius in plastic surgery, and in his work and by his writings gave a tremendous stimulus to the subject. Many of his methods and principles have not been improved upon and are still constantly employed. When Dieffenbach visited Paris all of the hospitals were thrown open to him so that he could demonstrate his remarkable plastic work.

An interesting sidelight on Dieffenbach and early newspaper publicity may be gathered from a paragraph in Sir Astley Cooper's notebook, October 8, 1834: "Prof. Dieffenbach called without an introduction to ask me to go to the Hôpital de St. Louis with him to see him make two new noses, which I declined as I did not wish to be mentioned in the papers."

In Europe, during the first half of the nineteenth century, great strides were made in evolving plastic principles and in developing operative procedures. The transplantation of skin and other tissues as employed in plastic surgery was a development of the latter part of the century.

Four surgeons in the United States also did pioneer work in the subject, and their influence on plastic surgery in this country was of great importance. These men were John Peter Mettauer (1787–1875); Joseph Pancoast (1805–1882); J. Mason Warren (1811–1867), and Thomas D. Mütter (1811–1859). I shall take the time to briefly consider their work.

Doctor Mettauer was born in Prince Edward County, Va., and received his A.B. degree at Hamden-Sidney College in 1806. He then went to the University of Pennsylvania and obtained his M.D. degree in 1809. He was a diligent student, an insatiable reader, and throughout his long life kept himself fully informed of advances in medicine and surgery.

At first his work was in general medicine, which included surgery, but his remarkable skill attracted many patients from all parts of this country, and soon he was able to devote his attention almost entirely to surgery. In 1837, he organized his group of private students into a Medical Institute, which, in 1848, became the Medical Department of Randolph-Macon College, and continued so until the suspension of that school in 1860. He occupied, at the same time, all the following Chairs during this period: Medicine and Surgery; Clinical Medicine and Therapeutics; Materia Medica; Midwifery and Medical Jurisprudence. Mettauer was quite eccentric and always wore an enormous stovepipe hat, which he seldom took off. He left directions that he was to be buried in it, and it took an eight-foot coffin to contain the body and hat, together with some other things he directed to be buried with him.

Mettauer lived and worked in Worsham, Prince Edward County, Va., which is near Farmville, except for a short time in Norfolk, Va., and for another short period in Baltimore, in 1835, as Professor of Surgery in Washington Medical College.

He performed the first operation for cleft palate in Virginia in 1827. His article on staphylorrhaphy, in 1838, was one of the best up to that time,

and his success in this type of work was well-known. He described an operation for epispadias and hypospadias, and was interested in many other plastic problems. He was a remarkable surgeon and far ahead of his time; he devised and made many new surgical instruments; he used wire sutures in curing vesicovaginal fistulae 12 years before Sims reported the same method; he removed more than 800 cataracts during his career; he operated 400 times for stone, and over 200 times for the relief of strictures, besides performing all the other operations then known to surgery.

Doctor Pancoast was born in Burlington, New Jersey, and was graduated in Medicine from the University of Pennsylvania in 1828. He was Professor of Surgery at Jefferson Medical College ten years later, and Professor of Anatomy in 1847. He devised the plow and groove suture which he used in rhinoplastic operations, and reported, in 1868, an operation for exstrophy of the bladder, in which skin flaps from the abdominal wall and groin were utilized for the reconstruction. He also devised many new operations on the eye and in the general surgical field. He employed pedicled-flaps and also free skin grafts on several occasions, and was much interested in all plastic problems. He was a voluminous writer and a great teacher.

Doctor Warren was born in Boston. He was graduated in Medicine from Harvard University in 1832, and immediately went abroad to observe surgeons in London, Edinburgh and Paris. He was interested in plastic surgery, as was his father, John C. Warren. On his return to Boston, he reconstructed a nose in 1834, by the use of a forehead flap, which was the first nasal reconstruction performed in this country, and, in 1840, he reconstructed another nose by using a flap from the arm. In 1843, he published a method of closing congenital clefts of the hard and soft palate at the same time by the use of mucoperiosteal flaps, and reported 14 cases.

Warren also employed successfully free whole-thickness grafts in making repairs on eyelids and noses. He operated for syndactylism and did many other plastic reconstructions requiring tissue-shifting, as well as a great deal of general surgery. He was a distinguished surgeon and a voluminous writer.

Doctor Mütter was born in Richmond, Va., and graduated in Medicine at the University of Pennsylvania in 1831. He then went to Europe as surgeon on the Corvette Kensington, and while there attended various clinics and returned the following year. He devoted himself to surgery, and, in 1841, ten years after his graduation, was Professor of Surgery in Jefferson Medical College. He was especially interested in burn contractures and the innumerable subsequent deformities and devised new methods for their relief by means of pedicled-flaps. He was successful with the repair of congenital lip clefts. His remarks on scars, in general, and methods of handling them are well worth while reading to-day by anyone interested in the subject. He was an excellent surgeon and a great teacher but cared little for writing.

The discovery of anesthesia, both general and local, made possible the carrying out of procedures in plastic surgery with safety and comfort, which could never have been undertaken previously.

Following the epochal discoveries of Louis Pasteur (1822–1899), and Joseph Lister (1827–1912), antisepsis and asepsis had a most important bearing on plastic surgery, and made feasible operative procedures which would be impossible unless wound infection could be eliminated. It is interesting to note, however, that the majority of the principles of plastic surgery had been evolved and in many instances successfully carried out long before "listerism" was thought of.

Following the work of Pancoast, Warren, Mütter and others, the use of pedicled-flaps became more common. The basic principles of the original Indian, Italian and French methods of flap-shifting were for the most part unchanged. However, it was not until the convincing papers of H. Maas (1842–1886), which appeared in 1884–1886, that widespread attention was given to the use of this method of tissue-shifting all over the body.

Then the progress of flap development was advanced by the "island-flap" method where the skin margins were completely severed and where the base tissues and included blood vessels and nerves formed the pedicle. This type of flap was devised and first employed by Robert Gersuny (1844–1924), of Teplitz, Bohemia, and was reported in 1887. In 1893, Theodore Dunham, of New York, first reported the sucessful use of the artery, with accompanying vessels and nerves, as the pedicle for a flap, and to him belongs the credit of devising this new conception.

Frantz Burian, of Prague, is said to have used the tubed-flap, in 1911, in the Balkan wars, but it was first reported by Filatof in 1916. It was independently developed by H. D. Gillies in 1917, at Sidcup, and to Gillies belongs the credit of showing its possibilities and in popularizing the procedure. All of the types of flaps mentioned, with many modifications, are now being constantly employed.

Before pedicled-flaps were employed in reconstructing noses, the Tilemaker caste in India are said to have successfully utilized free grafts of skin, including the subcutaneous fat, taken from the gluteal region, after it had been beaten with wooden slippers until a considerable amount of swelling had taken place. They used a secret cement for the adhesion, to which was ascribed special healing power. This was called the "Ancient Indian Method."

This is the earliest record of free whole-thickness grafting, although its successful application in total rhinoplasty must be doubted, as this is an accomplishment hardly possible even with modern surgical technic.

Hundreds of years passed, and up to the beginning of the nineteenth century, nothing of importance was done in regard to the transplantation of free grafts of skin. Then G. Baronio (1759–1811), the physiologist, carried out the following experiments in 1804.

In the first experiment, two whole-thickness pieces of skin of equal size and shape, without subcutaneous tissue, were cut from either side of the root of the tail of a sheep, and were immediately transferred to opposite sides.

The second experiment was similar except that the pieces of skin were kept detached for 18 minutes. In the third experiment, larger pieces were

used 12.5x7.5 cm. (5x3 inches) including the subcutaneous tissue and a bit of muscle. These pieces of tissue were left detached for one hour before being transferred to opposite sides. All of the grafts were successful, and the grafts bled when cut into, ten to 12 days after transplantation. Little notice was taken of these very significant experiments.

Attempting to revive the "Ancient Indian Method," Bünger, of Marburg, in 1823, reported the partly successful transplantation of a free whole-thickness skin graft from the thigh for the repair of a nasal defect, but von Graefe did not succeed with his attempts at rhinoplasty with free grafts, and Ph. v. Walther (1782–1849), Dieffenbach, and C. W. Wutzer (1789–1863) were no more successful.

The report of J.-L. Reverdin (1842–1929) to the Société Impériale de Chirurgie, in Paris, on December 8, 1869, of the hastening of the healing of granulating wounds by means of small, very thin, detached bits of transplanted skin, which he called "epidermic grafts," and the discussion of this paper one week later, was the spark which was needed to start the flame of interest in the subject of skin grafting throughout the world. In 1872, Reverdin admitted that his graft contained a portion of the corium, and, therefore, was not an epidermic graft.

L. X. E. L. Ollier (1830–1900), of Lyon, in 1872, successfully transplanted much larger films of skin (4, 6, and 8 cm. square) using the entire epidermis and a portion of the dermis.

At the Fifteenth Congress of the German Surgical Association, in 1886, Carl Thiersch (1822–1895) presented his perfected method of skin grafting, in which he covered the defects with large films of epidermis with a very thin portion of the dermis, but gave no credit to Ollier who had done the same thing 12 years previously.

Within the last few years, the Ollier-Thiersch type of graft has been cut much thicker, so as to include about one-half of the thickness of the corium and has been called the "split-graft" (Blair and Brown), the "razor-graft" (Gillies), the "midthickness graft," *etc.*

In order to obtain a more stable healing, investigators again began to try out the use of the whole-thickness of the skin and a number of successful results were reported. In 1875, John Reissberg Wolfe (1824–1904), of Glasgow, reported the successful plastic repair of a defect about the lower eyelid with a free whole-thickness graft 2.5x5 cm. (1x2 inches) from the arm. He is generally accredited with introducing this method. To Fedor Krause (1857–1937), of Altoona, however, is due the credit of bringing whole-thickness grafts into practical use. In 1893, at the Twenty-second Congress of the German Surgical Association, he reported his perfected technic and advised the use of the whole-thickness graft in all cases where the Ollier-Thiersch graft had been found lacking.

In looking about for a simpler technic for skin grafting which could be used without difficulty by almost anyone, J. S. Davis described, in 1914, what he called the "small deep graft," which was based on Reverdin's idea,

but instead of being the thinnest bit of superficial skin that could be cut, it included the full-thickness of the skin at its center, and this type of graft has turned out to be of great general value. Free skin grafts based on the original types and methods, either with or without changes in technic, are more universally used to-day than ever before.

As time went on, it was found that in the evolution of modern plastic surgery, the transplantation of tissues other than skin were required. These tissues were bone, cartilage, periosteum, fascia, fat, tendon, muscle, nerve, mucous membrane and cornea, and their importance in plastic surgery is becoming more and more apparent. The methods of their free transplantation were developed, for the most part, late in the nineteenth and in the beginning of the twentieth century.

In addition to the transplantation of the individual tissues mentioned, parts already formed have been transplanted. J. L. Joyce has replaced a *missing thumb by transplanting the ring finger from the other hand. Fingers* or portions of fingers have been replaced by toes by a number of surgeons, the latest case being reported by V. P. Blair and L. T. Byars. Fingers have also been used in reconstructing noses.

Deformities, such as congenital clefts of the lip and palate, syndactylism, epispadias, hypospadias, congenital and traumatic scar contractures, hemangiomata, lymphangiomata, hypertrophied breasts, extensive moles, *etc., etc.,* have always been of interest to the plastic surgeon. The story of the development of methods of treatment in each of these groups and of those who developed them is fascinating, but lack of time precludes their consideration here.

In the First World War, plastic reconstruction of wounded men in the belligerent countries abroad was confined to the face and jaws, and great hospitals were organized where faciomaxillary cases were segregated and cared for.

Later, in our own army, under Col. Vilray P. Blair, a division was formed whose work was similarly limited, and this was also called the Faciomaxillary Division, as in the British Army. The plastic work of the rest of the body, which is equally important, was not segregated but was undertaken as routine work by the general or orthopedic surgeons.

I urged, at that time, that the Division be expanded to include all cases requiring plastic reconstruction, but could not put it over, as there was no appreciation of the necessity of general plastic surgery by those with the power to act. I have again urged this expansion in the present emergency, and it seems probable that the suggestion may be carried out in the new tables of organization, which have been prepared in the program of Medical Preparedness, and that the Division will be called the Plastic and Faciomaxillary Division. Should this be done, and the division be properly developed and manned, it will add enormously to the efficiency of the care of patients with lesions requiring plastic surgery of the neck, trunk and extremities, as well as of the face and jaws.

In the present war, with its new type of bombing and machine-gun attack on civilians as well as soldiers, there will be great numbers of patients requiring the help of the plastic surgeon. It is reported that in England, as early as August, 1940, ten special centers had been established for the treatment of faciomaxillary and plastic cases, and that early transfer of these cases is particularly enjoined.

While no definite information is available from the Axis powers, doubtless arrangements have also been made by them for the prompt evacuation, by plane or other means, of the wounded requiring plastic work.

In the light of the rôle played by plastic surgery in mutilating wounds in the World War and in the present conflict, it seems evident that in civil life in this mechanized age with its speed and numerous accidents, that the close cooperation of trained plastic surgeons should be in order in the Accident Department as well as in the Surgical Service of every great hospital.

In bringing the subject up to date in the United States, it is interesting to note that less than 25 years ago there was no Division or Department exclusively devoted to plastic surgery in any medical school, hospital, or clinic in this country. As far as I can ascertain, the first effort in this direction was made by the speaker at the Johns Hopkins Hospital, and in a paper read before the Surgical Section of the American Medical Association in 1916, I advocated the formation of a separate Division of Plastic Surgery, and was thought "a little touched" by the heads of the surgical departments everywhere. This was the first of several papers on the same general subject, and I feel that they have borne fruit, as at the present time, in spite of bitter early opposition, there are well-organized Divisions or Departments of Plastic Surgery in the majority of up to date great medical schools, clinics and hospitals, and the care of patients requiring plastic and reconstructive surgery has, in consequence, been enormously improved.

There are two recognized organizations of plastic surgeons in the United States—The American Association of Oral and Plastic Surgeons, and the Society of Reconstructive and Plastic Surgeons. Both of these groups have one or two meetings each year in different cities, at which time operative clinics are observed, scientific papers presented and ideas are interchanged.

Through the efforts of Vilray P. Blair, an American Board of Plastic Surgery has been organized, which is made up of representatives of widely distributed groups interested in this special type of surgery. The Board is a subsidiary of the American Board of Surgery. Two types of certificates are issued by the Board: (1) Those covering plastic surgery of the general surgical field; and (2) those covering single surgical fields.*

There was no recognition for plastic surgeons by the American College of Surgeons until recently, but now "Fellows," who are limiting their practice to plastic surgery, are so listed in the year book. Already, several

*At a meeting of the Advisory Board for Medical Specialties of the American Medical Association on February 16, 1941, the American Board of Plastic Surgery was given the status of an independent board.

institutions have been approved by the Council of Medical Education and Hospitals of the A.M.A., as accepted in the training of interns and Fellows in plastic surgery.

Over 35 years ago, my friend, Doctor J. M. T. Finney, who knew of my interest in plastic and reconstructive surgery, suggested that I concentrate on this work. I took his advice, and my first paper on a subject dealing with plastic surgery was published in 1907. Since that time, I have been particularly interested in the ethical development of plastic and reconstructive surgery in this country, and it is very gratifying to think that possibly I have had something to do with placing this important surgical specialty upon its present status as a recognized subdivision of general surgery.

BIBLIOGRAPHY

APPENDED ARE SOME OF THE REFERENCES CONSULTED IN THE PREPARATION OF THIS PAPER

Arnold, Howard Payson: Memoirs of J. Mason Warren, Boston, 1886.

Baronio, G.: Degli Innesti Animali. Milan, 1804.

Idem: Über anamalische Plastik, Ubersetz. f. Bloch Halberstadt. 1819.

Bhishagratna, K. K. L.: The Sushruta Samhitá. Calcutta, 1907. 3 vols.

Blair, V. P., and Brown, J. B.: The Use and Uses of Large Split Skin Grafts of Intermediate Thickness. Surg., Gynec., and Obstet., 49, 82, 1929.

Blair, V. P., and Byars, L. T.: Toe to Finger Transplant. Tr., South. Surg. Assn., 52, 465, 1939.

Breasted, J. H.: The Edwin Smith Surgical Papyrus. Univ. of Chicago Press, 1930.

Buck, Albert H.: The Growth of Medicine from the Earliest Times to About 1800. Yale Univ. Press, New Haven, 1917.

Bünger: Rhinoplasty from a Full-Thickness Skin Graft. J. der Chirurgie und Augen-Heilkunde. C. F. Gräfe und Ph. v. Walther, 1823, p. 569.

Bussmaker et Daremberg: Oeuvres d'Oribase, *etc.* Paris. L'Imprimerie nationale, 1851–1876. 6 vols.

Carpue, J. C.: An Account of Two Successful Operations for Restoring a Lost Nose from the Integuments of the Forehead. London. Longman, Hurst, Rees, Orme and Brown, 1816.

Cordell, E. F.: The Medical Annals of Maryland. Baltimore, 1903.

Coxe, J. R.: Writings of Hippocrates and Galen. Philadelphia, Lindsay & Blakiston, 1846.

Cutter, Irving S.: Landmarks in Surgical Progress. Intern. Abst. Surg., 51, 275. October, 1930.

Daremberg, Ch.: Oeuvres de Galien. Paris, 1854. 2 vols.

Davis, J. S.: The Use of Small Deep Skin Grafts. J.A.M.A., 63, 985, September 19, 1914.

Idem: Plastic and Reconstructive Surgery. J.A.M.A., 67, 338, July 29, 1916.

Idem: The Division of Plastic Surgery: Its Organization; Its Needs; Its Field of Usefulness. Tr. West. Surg. Assn., 1932, p. 209.

Dawson, Warren R.: The Earliest Surgical Treatise. Brit. Jour. Surg., 20, 34–43, 1932–1933.

Dieffenbach, J. F.: Mémoire et observations sur la restauration du nez. Jour. compl. d. se méd., 39, 162, 1831.

Dorrance, George M.: The Operative Story of Cleft Palate. W. B. Saunders & Co., 1933.

Dunham, Theodore: A Method for Obtaining a Skin Flap from the Scalp and a Permanent Buried Vascular Pedicle for Covering Defects of the Face. ANNALS OF SURGERY, 17, 677, June, 1893.

Esser, J. F. S.: Biological or Artery Flaps of the Face. Institut Esser de Chirurgie Structive, Monaco, 1933.

Filatoff, W.: Plastie tige ronde. Westnik oftalmol., 1917, Avril, Mai, Nos. 4, 5 (Russe).

Idem: Operations plastiques a tige ronde ambulante. Presse Medicale, 31, 1061, December 19, 1923.

Gersuny, R.: Plastischer Ersatz der Wangenschleimhaut (Island Flap). Zentralbl. f. Chir., 14, 706, September 17, 1887.

Garrison, Fielding H.: An Introduction to the History of Medicine. Philadelphia, Saunders & Co., 1917.

Gillies, H. D.: Plastic Surgery of the Face. London, Oxford Univ. Press, 1920.

Idem: Experiences with Tubed-Pedicle Flaps. Surg., Gynec., and Obstet., 60, 291, February 15, 1935.

Graefe, C. F. v.: Rhinoplastic oder die Kunst, den Verlust der Nase organisch zu ersetzen, Berlin, 1818.

Graham, Harvey: The Story of Surgery. New York, Doubleday, Doran & Co., 1939.

Gurlt, E.: Geschichte der Chirurgie und ihrer Ausübung. Berlin, 1898. Verlag von August Hirschwald. 3 vols.

Jee, B. S.: A Short History of Aryan Medical Science. Macmillan, 1896.

Johnston, Geo. Ben: A Sketch of Dr. John Peter Mettauer of Va. Tr. Am. Surg. Assn., 23, 1, 1905.

Joyce, J. L.: New Operation for Substitution of a Thumb. Brit. Jour. Surg., 5, 499, January, 1918.

Kelly, H. A., and Burrage, Walter L.: American Medical Biographies. Baltimore, Norman Remington Co., 1920.

Krause, F.: Über die Transplantation grosser ungestielter Hautlappen. Verhandl. d. deutsch. Gesellsch f. Chir., 22, 46, 1893.

Lexer, E.: Die freien Transplantationen. Stuttgart, Ferdinand Enke, 1919.

Idem: Malformations, Injuries and Diseases of the Face and Plastic Operations. Von Bergman's System of Surgery. Chaps. X–XIII. New York., Lea Bros. & Co., 1904.

Lisfranc, J.: Mémoire sur la rhynoplastie. Mém. Acad. de méd., 2, 145, 1833.

Maas, H.: Über Plastik mit frischen gestielten Lappen aus ent fernteren Koerpertheilen. Archiv. f. klin. Chir., 31, 559, 1885.

Idem: Weitere Fälle von Plastik mit frischen gestielten Lappen aus entfernteren Koerpertheilen. Verhandl. d. deutsch. Gesellsch. f. Chir., 14th Kongress 1885, 447.

Idem: Weitere Fälle von Plastik mit frischen gestielten Lappen aus entfernteren Koerpertheilen. Arch. f. klin. Chir., 33, 323, 1886.

Mettauer, J. P.: Staphylorraphy. Am. Jour. Med. Sci., 21, 309, February, 1838.

Mütter, Thomas D.: Cases of Deformity from Burns Relieved by Operation. Am. Jour. Med. Sci., 4, (n.s.) 66, July, 1842.

Neuhof, H.: The Transplantation of Tissues. New York, D. Appleton & Co., 1923.

Ollier, L.: Greffes cutanées ou autoplastiques. Bull. de l'Acad. de méd., Paris, Sérié, 243, 2, 1872.

Pancoast, J.: Plastic Operations. Am. Jour. Med. Sci., n.s., 4, 337, October, 1842.

Power, Sir D'Arcy: Some Early Surgical Cases. The Edwin Smith Papyrus. Brit. Jour. Surg., 21, 1, July, 1933; *ibid.*, 22, 385, January, 1934.

Renouard, P. V.: History of Medicine from Its Origin to the 19th Century. Translated by C. G. Comegys. Philadelphia, J. B. Lippincott, 1856.

Reverdin, J. L.: Greffe épidermique. Bull. de la Soc. de Impériale de Chir., Paris, 2nd series, 493 and 511, December 8 and 15, 1869.

Idem: De la greffe épidermique. Arch. gén. de méd., 19, 276; 555; 703, 1872.

Royle, J. F.: The Antiquity of Hindoo Medicine. London, 1837.
Roux, J.-P.: Mémoires sur staphylorrhaphie, Paris, J.-S. Chaude, 1825, p. 84.
Sen-Gupta, K. N. N.: The Ayurvedic System of Medicine. 1919, 3 vols.
Spencer, W. G.: De medicina. English translation of Celsus in 3 vols. Harvard Univ. Press, 1938.
Tagliacozzi, G.: De curtorum chirurgia per insitionem. Venice, 1597.
Thiersch, C.: Über Hautverphlanzung. Verhandl. d. deutsch. Gesellsch. f. Chir., 15, 17, 1886.
Warren, J. M.: Rhinoplastic Operation. Boston Med. Surg. Jour., 16, 69, 1837.
Idem: Rhinoplastic Operations with Some Remarks on Autoplastic Methods. Boston Med. Surg. Jour., 22, 264, 1840.
Wolfe, J. R.: A New Method of Performing Plastic Operations. Brit. Med. Jour., 2, 360, September 18, 1875.
Zeis, Eduard: Handbuch der plastischen Chirurgie, 1838.
Idem: Die Literature and Geschichte der plastischen Chirurgie, 1863.

BLOOD AND BLOOD SUBSTITUTES IN THE TREATMENT AND PREVENTION OF SHOCK: WITH PARTICULAR REFERENCE TO THEIR USES IN WARFARE*

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THE SUBJECT assigned to us in this symposium is that of the use of blood and blood substitutes in the treatment and prevention of shock. This is an important assignment because it is generally agreed that the single most effective method for combating shock lies in supplementing the reduced blood volume by the intravenous introduction of fluids, and it is a timely subject because of the increase in the number of the injured as a result of world warfare. It is a difficult subject, particularly at the moment, because of the rapid strides that are being made as a result of intensive and extensive investigations on methods for obtaining, preserving, transporting and administering blood or substitutes for blood.

It is to be understood that this communication deals, in the main, with wound shock (secondary or hematogenic shock) in which there is a decrease in the blood volume due to the loss of whole blood or plasma or both, and this loss may be local or general or both. The consequences of this reduction of blood volume are an inadequate venous return to the right heart, a decline in cardiac output, a fall in blood pressure, and stagnant anoxia, *i. e.*, peripheral circulatory failure. It has been our contention[1a, 1b] that the fluid loss in the early stages of peripheral circulatory failure is mainly local, at and near the site of injury, and that the general loss of plasma usually does not occur until after the reduced blood volume and pressure and the associated anoxia have resulted in a general increase in capillary permeability. Previous studies[2] demonstrated that a sustained decline in blood volume and blood pressure as a result of simple bleeding without associated trauma to tissues results in a general increase in capillary permeability with loss of fluid. A decline in blood pressure without a marked decrease in blood volume, such as occurs in reflex, primary or neurogenic shock does not result so readily in this general damage. The best means devised, thus far, for preventing or combating this general increase in capillary permeability in secondary shock consists of the introduction of adequate quantities of whole blood or plasma. These fluids should not be administered in fixed quantities but according to the needs of the patient. If a small quantity is

* Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

† Aided by a Grant from the Division of Medical Sciences of the Rockefeller Foundation.

ineffective, it does not follow necessarily that several times that amount may not result in permanent benefit.

Limiting our remarks, for the moment, to the use of whole blood and plasma, the problem is considerably more complicated in warfare than in the civilian practice of surgery. Present methods of warfare are resulting in the injury of many noncombatants and the treatment of these is not vastly different from that of peace-time accidents. Naturally, the larger volume of such injuries requires an increase in personnel, in equipment, and in available blood and plasma. The major difference in the preparation for the treatment of the combatants and noncombatants lies in the facts that the former are more likely to be away from the source of supply, and that continued enemy activity is more apt to interfere with prompt treatment. Distance from the source of supply of the whole blood and plasma introduces many perplexing problems, the greatest of which is the preservation of these fluids. When the distance is great, the use of whole blood, other than that obtained locally from the military personnel, has been considered unsafe and impracticable. Even the use of plasma presents certain problems, the greatest of which are the sterility of the solution and preservation without denaturation. These points will be considered in more detail subsequently.

The ideal treatment of shock consists of replacing fluid at the earliest possible moment in the form in which it has been lost. Unfortunately, this ideal is not obtainable under all circumstances, and the employment of less effective means of therapy may be necessary. Means by which the reduced blood volume may be supplemented, at least temporarily, and their limitations include the following:

THE EFFECTS OF INTRAVENOUS INJECTION OF VARIOUS FLUIDS UPON SHOCK

Isotonic Solutions of Salt or Glucose.—These are of much greater value in the prevention of than in the treatment of shock. Dehydration is one of the most frequent of the contributing causes of shock and the administration of one or both of these fluids is indicated. When the loss of blood in uncomplicated hemorrhage has been slight or moderate, a spontaneous increase in the blood volume occurs as a result of the passage of fluid from the tissue spaces into the blood stream. Tissue fluid must, therefore, be classed as a blood substitute, and this is supplemented by the passage of red blood corpuscles and plasma proteins from their reserve depots. The introduction of salt or glucose solutions in adequate quantities replaces the deficit in the extracellular fluids.

When the conditions are more extreme and there is an associated local or general gross damage to many capillaries, solutions of crystalloids cannot be considered correctly as substitutes for blood because they are lost from the blood stream rapidly and are ineffective in maintaining the blood volume and pressure. In fact, the intravenous injection of large quantities of solutions of crystalloids in the presence of gross capillary damage may actually result

in harm rather than benefit. In association with Dr. J. W. Beard, and others,[3a, 3b] it was found, under these circumstances, that the administered crystalloid solutions wash protein out of the blood stream and that an accentuated hypoproteinemia results. Tissue edema rather than an increase in the blood volume occurs. The unfortunate situation that one encounters frequently during the intravenous administration of crystalloids is that the concentration of protein is decreasing while that of the red blood cells is increasing, and this is convincing evidence that plasma is being lost from the blood stream and that the blood volume is not being restored.

Somewhat similar statements may be made regarding the injection of *hypertonic solutions of crystalloids* in the treatment of patients with gross local or general damage to capillaries. A transient beneficial hydremia is followed by rapid escape from the blood stream of both fluid and protein causing tissue edema rather than a sustained increase of the blood volume.

The obvious conclusion is that solutions of crystalloids are not satisfactory and acceptable blood substitutes in the treatment of shock. Amberson[4] recently stated that the only effective blood substitutes are those which contain sufficient colloidal material to give a colloidal osmotic pressure approximating that of normal blood and that these are blood plasma or serum, Ringer-Locke solutions containing dissolved hemoglobin, and gum-saline.

Gum acacia probably ranks next to blood plasma or serum as the most successful substitute for whole blood. There is little doubt that it is less effective, and more dangerous than plasma or serum in the treatment of shock. Amberson[4] has enumerated the objectionable features encountered in the use of gum-saline. These are as follows: (1) The sedimentation rate of the red cells is greatly increased; (2) the red corpuscles are coated with gum, and the diffusion of oxygen is hindered; (3) the osmotic pressure is not maintained for much more than 48 hours since gum leaves the blood stream fairly rapidly; (4) gum is fixed in some of the tissues, particularly the liver and may remain there for years; (5) retention in the liver results in a diminution in the concentration of plasma proteins; and (6) there is considerable danger from antigenic action. These objections are not so serious that they prohibit the use of gum acacia if whole blood or plasma is not obtainable. On the other hand, we are inclined to agree with Phemister,[5] Trout,[5] and others that gum acacia should be employed only in case of dire emergency.

Gelatin-saline is only slightly superior to a colloid-free saline in its ability to restore the blood volume and there are many objections to its use. *Hemoglobin-Ringer* solution may serve a temporary purpose but hemoglobin leaves the blood stream rather quickly. The resulting hemoglobinuria may lead to renal complications due to deposition of hematin in the tubules unless the urine is kept alkaline. The situation here is similar to that encountered following a severe transfusion reaction associated with hemolysis and hemoglobinuria.

Whole blood, fresh or preserved, as might be anticipated, is a satisfactory

fluid for intravenous introduction in the treatment of shock. It is clear that it serves two purposes, restoration of erythrocytes and augmentation of the plasma protein concentration. The loss of red cells may or may not have occurred in shock and inasmuch as the fall in blood volume is related to plasma protein deficit rather than to anemia, the restoration of cells in any case is relatively of less importance and, indeed, may be ignored except in extreme instances of repeated hemorrhage. A considerable proportion of a given volume of whole blood, therefore, is utilized in ameliorating a circumstance which if it exists at all, is of secondary importance.

It is our impression, however, that the administration of large amounts of whole blood in the treatment of shock even when accompanied by hemoconcentration is not contraindicated. Observations by Wood and Blalock[6] show that the erythrocyte count in the circulation may be increased very significantly without causing detectable untoward symptoms providing the blood volume is maintained at essentially a normal level. On the other hand, in the presence of a decline in blood volume large increases in cell count and viscosity undoubtedly impose an additional burden upon the already impaired circulation.

Liquid blood plasma and serum will be considered in more detail because it is generally agreed that they are the most useful of all fluids in shock therapy whether the condition has been brought about by simple bleeding or other causes, and because their use in military zones is free of several complications which accompany the employment of whole blood transfusions. Although certain conditions arising from warfare have revived the interest in use of serum or plasma, the subject is not new. The earlier literature was reviewed by Amberson,[4] in 1937. He stated: "It is now widely recognized that due to its organic and colloidal constituents blood plasma or serum, when properly prepared, may replace a very considerable fraction of whole blood in the mammalian body, without disturbance of normal function. Richet and Brodin (1917) were able to get recovery, in dogs, after replacement of as much as 96 per cent of the normal blood by horse serum. Even better results were found by Richet, Brodin and Saint-Girons (1917) and Richet (1919) when plasma was used instead of serum. Couvreur and Clement (1919), however, could not save dogs with serum after hemorrhage. Other excellent results after replacement of blood by plasma or serum have been observed by Guthrie and Pike (1907), Mann (1918), Foster and Whipple (1922), Rossius (1925), Kallius (1929), Weech, Goetsch and Reeves (1933) and others." Other pertinent observations include those of Rous and Wilson,[7] in 1918. They noted experimentally when the hemoglobin is reduced by not more than three-fourths, the plasma without the erythrocytes being replaced, that there is no marked alteration in the appearance or behavior of the animal. They concluded that it is not essential to supply blood corpuscles in ordinary cases of acute hemorrhage. Johnson and Blalock[8] found that the loss of whole blood is tolerated better than is the loss of an equal volume of blood plasma. Beard and Blalock[3] noted

that the intravenous injection of blood serum in conjunction with intestinal trauma resulted in less alterations in the various circulatory functions than the introduction of whole blood.

Bond and Wright,[9] and Mahoney[10] found that plasma and serum are effective in the treatment of hemorrhage and shock. More recently Levinson, and his associates,[11] have emphasized the fact that serum or plasma is effective in supplementing the blood volume following severe hemorrhage in which there was a marked reduction in red blood corpuscles. Further evidence as to the value of plasma and serum as blood substitutes is supplied by the studies of Carrel and Lindbergh[12] who, using aseptic technic, succeeded in maintaining life and promoting growth for extended periods of isolated organs which were perfused with serum.

Plasma or serum need not be typed prior to administration although it is advisable to pool various lots in order to suppress the iso-agglutinin activity. They may be preserved for considerable lengths of time (*vide infra*) and, when available may be given with no more delay than that encountered in the injection of saline or saline-glucose solutions.

In addition to these considerations, plasma or serum is distinctly valuable from the point of view of nutrition, the protein of these fluids being readily available for catabolism as a source of energy. Nitrogen balance may be maintained even in a starving animal by transfusion of adequate amounts of these fluids,[13-16] and is more effective than whole blood in this respect.

Dried Plasma or Serum.—Desiccated plasma or serum, when properly prepared, may be regenerated by solution in water or salt solution into their original liquid forms. The therapeutic advantages of their use in shock are precisely those of fresh, unaltered liquid plasma or serum, which have already been discussed. The advantages of this form of blood substitute distinct from therapeutic value, and the means of preparation and preservation will be referred to subsequently in the discussion of preservation of blood and plasma or serum.

In comparing the virtues of whole blood and plasma or serum in the treatment of shock, it is worth while to consider the following proposition: The circulating hemoglobin may be rapidly reduced to one-fourth of the normal level with comparative safety; however a loss of approximately one-half of the total blood volume is usually fatal to man or animal. The presence of one million erythrocytes per cubic millimeter of blood is easily sufficient to maintain life providing the total circulating fluid volume is normal or essentially so, hence, the most important element in replacement therapy consists of the introduction of plasma or serum into the circulation. Volume for volume plasma supplies approximately twice as much osmotically active protein as does whole blood, it is nutritionally more effective, it need not be typed, it is more easily administered, and finally, it is readily preservable in the liquid state for considerable periods, or, suitably prepared as a dry powder, it may be stored for any length of time desired. Preserved whole blood, on the other hand, has a limited life of from two to three weeks.

The disadvantages of plasma or serum comprise the additional technical difficulties in their preparation, and the necessity for obtaining a larger amount of blood from donors in order to supply a given quantity of these fluids.

A point about which there is some difference of opinion is whether the plasma or serum should be used in concentrated or unconcentrated form. It is likely that the choice should depend somewhat on the nature of the injury. If the plasma volume is markedly diminished and the tissues are dehydrated, the use of the unconcentrated form appears to be indicated. On the other hand, Bond and Wright,[9] and Best and Solandt[17] have employed the concentrated form with good results. The latter authors precede the introduction of concentrated serum by an injection of pituitrin.

Thus far in this discussion, plasma and serum have been considered as though they are identical, ignoring the difference imposed by the presence of fibrinogen and anticoagulant in the former. This is not an important difference from the therapeutic viewpoint. There is, however, some evidence that something happens to the blood in the process of clotting which increases the likelihood of unfavorable reactions on intravenous injection of the separated serum. Stevens and Lee,[18] Brodie,[19] and O'Connor[20] state that a vasoconstrictor substance results from the process of blood clotting and that this is absent in citrated plasma. The main disadvantage of plasma is that veils of fibrin may form in the fluid, sometimes amounting to a thick jell, although these are readily removed by filtration prior to administration.

Opinion is somewhat divided as to the choice of plasma or serum. Levinson and his associates[11] prefer serum; Strumia, and his coworkers[21, 22] prefer plasma, while Best and Solandt[23] state that either is satisfactory. The latter authors stated: "We wish again to emphasize the point that plasma and serum free from reaction-producing substances are physiologically and therapeutically identical and may be used interchangeably. It will be regrettable if discussion of the relative merits of these two materials should in any way impede their production or inhibit their use under appropriate conditions." The extensive use of plasma is due at least partially to the fact that unclotted blood in blood banks may be converted into plasma after its age makes inadvisable its use as whole blood. It is our impression that the use of plasma is slightly safer than that of serum.

COLLECTION, PRESERVATION, TRANSPORT AND DISPENSATION OF WHOLE BLOOD, PLASMA AND/OR SERUM

Collection of considerable quantities of blood such as are required during the active phases of war is a quite different problem from peace-time provision of blood in civilian hospitals, and requires extensive donor organization. Detailed comment upon this socio-economic administrative problem is outside the province of this symposium. Suffice it to say that whatever the type of organization is adopted, large numbers of typed donors are required, particularly those of the universal type. The use to which the organization is put

is another matter and upon this a few brief statements might be made respecting the authors' point of view.

For most efficient practice it would appear best to have all transfusions in all areas made with preserved blood or blood substitutes when these are available. To meet acute emergencies during which these products are unavailable, typed military personnel or preferably local civilian universal type donors should be available to supply blood for immediate transfusion. The large effective donor organizations should be in centers where preserved blood and plasma are prepared for subsequent transport to areas where they are needed. The smaller civilian donor organization thus would be called upon only in combat emergency, or to supplement the blood supplied by the larger centers should that become inadequate for the accumulation of sufficient stores.

It is clear that these organizations would function most efficiently as a steady source of blood for these preparations, and in the large centers great stores, particularly of plasma, liquid or dry, could be accumulated. In this way a considerable economy of blood is achieved as stored whole blood becoming over-aged may be reclaimed for its plasma. It would appear that the German Army plan of preserving whole blood only from universal donors is desirable. Plasma, of course, may be prepared and dispensed without regard to typing as long as pooled lots are employed.

(1) WHOLE BLOOD

Collection.—Whole blood collected from suitable donors may be employed as follows: (a) For immediate transfusion; (b) preserved for subsequent transfusion; (c) the plasma separated and preserved as liquid plasma or converted to dry plasma. Preserved blood, if not used for transfusion within certain limits of time, may be reclaimed for its plasma which, in turn, may be preserved or converted to dry plasma. On the other hand, the preliminary observations of Strumia[5] indicate that dried plasma should be prepared from blood plasma that has not been kept in the liquid state for more than two days. It is generally agreed that sodium citrate is the anticoagulant of choice in the collection of whole blood.

Fresh whole blood transfusion is a well-established procedure and need not be commented upon in detail. Under conditions of warfare in which organization may or may not be disrupted, it would seem desirable to adopt for collection a standard equipment and procedure characterized by simplicity and safety even at considerable additional expense. The Baxter system of vacuum bottles is a good example of standardized equipment and technic suitable for manipulation under almost any conditions. Such a system permits relatively unskilled personnel to collect blood from donors. In acute emergencies, when preserved blood or blood substitutes, or standard equipment is unavailable, some improvisations in technic might have to be introduced. The objection to the vacuum bottle system when this is necessary

is the additional load upon transport in keeping the requisite equipment with a given unit.

In collecting whole blood from large donor organizations for preservation or for conversion of the plasma, standardized equipment is, again, desirable. A vacuum bottle system has the advantages of ease of handling with minimum opportunity for contamination. This is particularly important in the preparation of liquid plasma which is to be preserved for a long time. The collected blood should be typed, and the Wassermann reaction tested. In respect to the latter, the Kahn test might be preferable, inasmuch as the combination of a negative Wassermann and positive Kahn test is encountered more frequently than is the reverse of this.

Preservation.—Much information respecting the problem of preservation of whole blood is to be found in recent papers by DeGowin, Harris and Plass,[24] Scudder, Drew, Corcoran and Bull,[25] Bull and Drew,[26] and many others.

It has been shown that blood should be collected in a cold container, that it should be traumatized as little as possible, that it should be stored at approximately 4° C., and should not be brought to body temperature before being given to the patient.[27] The two most important changes occurring in stored blood are diffusion of potassium from the cells into surrounding plasma, and hemolysis, the former preceding the latter. Other changes include the destruction of white blood cells, and platelets and a decrease in prothrombin. Preservatives may alter the time at which hemolysis begins and the rate at which it proceeds; for example, the addition of large amounts of glucose solution as advocated by Rous and Turner[28]; however, the same end may be achieved by increasing the glucose concentration without excessive dilution.[24] Under optimum conditions whole blood may be preserved satisfactorily without serious hemolysis for a month, but hemolysis sufficient to render use of the blood inadvisable may be encountered any time after the first few days. The diffusion of potassium into the plasma is apparently not of grave significance providing the blood is administered slowly to the patient. It does, however, indicate a fundamental alteration in the permeability of the red cell to basic cations, and this appears to be related to a diminution in capacity for respiration by the cell, although the capacity for oxygen transport is unchanged.[29] The relation of these findings to the subsequent fate of these cells following reinjection is not as yet clear. In the case of preserving blood which may later be reclaimed for plasma, a container which allows only a small surface contact between plasma and the sedimented cells serves to cut down the diffusion of potassium into the supernatant plasma. In any event preserved blood not over two weeks of age is usually as effective as fresh blood in the treatment of shock.

The alteration in white cells, platelets and prothrombin appear to be unimportant, but even though blood has considerable antiseptic powers, maintenance of asepsis in preserving blood is even more important than in per-

forming fresh whole blood transfusion. Vacuum bottles are almost ideal in this respect.

Transport.—The preliminary observations of DeGowin and Plass[5] indicate that transportation of whole blood by various conveyances may be undertaken provided certain precautions are observed to prevent trauma or damage to the blood. These observations have not as yet been published. Liquid plasma or dried plasma, however, present far simpler problems in the matter of transport.

Dispensation.—This is a well-established procedure. In the case of preserved blood, observation of conservative age-limits, discard of frankly hemolyzed preparations, filtration, and administration without previous warming will eliminate most untoward reactions.

The use of whole blood from blood banks is certainly a practical means of treating injuries among the civilian population in time of war, and it will probably also be a feasible therapeutic agent in some of the larger army hospitals. There remains, however, the fact that the exigencies of warfare render plasma a more suitable fluid, all factors being considered.

(2) PLASMA

Greater emphasis will be placed upon problems related to plasma than to whole blood in this symposium because information regarding them is less well-known and because plasma in a suitable form may be more readily available under combat conditions.

Collection.—Plasma, for subsequent transfusion either before or after preservation, may be separated from whole blood collected for that purpose alone, or from preserved whole blood which has passed the age limit for safe use. There are a good many controversial points about the collection of plasma yet to be solved; however, it is generally agreed that rigid asepsis is imperative. There is no doubt that this may be achieved best by use of vacuum bottles both for the collection of the original whole blood and as a container for the separated plasma. As stated previously, the vacuum bottle system is expensive, but this is probably justifiable in the treatment of war injuries. By the use of such a system, Elliott, Busby and Tatum[30] demonstrated no organisms on culture of 150 specimens of plasma, some of which had been stored at room temperature for as long as 18 months. From the standpoint of efficiency, it would appear desirable to employ the same "system" of apparatus and technic in collection of plasma as that used for whole blood.

Two methods may be employed for separation of cells from plasma, spontaneous sedimentation and centrifugation. The former yields a volume of plasma equal to approximately one-third that of the original whole blood-citrate mixture, whereas after centrifugation the volume of plasma obtained is usually somewhat greater than one-half the original volume. Sturgis[5] prefers spontaneous sedimentation despite the smaller yield because (a) less special apparatus is required; (b) heating and trauma of the blood

in connection with centrifugation are avoided, thus reducing hemolysis; and (c) the fewer manipulations reduce the chances of bacterial contamination. He suggests that the plasma be separated from the cells after 48 hours' spontaneous sedimentation at 4° C.

If centrifugation is employed, Strumia[5] advises chilling the interior of the centrifuge with dry ice. Elliott, and his associates[30] recommend that the centrifuged mixture be placed in the refrigerator for 12 hours before aspirating the plasma in order to further reduce its cell count. Brief, cold centrifugation after spontaneous sedimentation does not appear to promote hemolysis if the red corpuscles and plasma are not mixed again prior to centrifugation.

Gross precipitates are apt to form in plasma after its separation from cells. Elliott, Busby and Tatum[30] found that the quantity of these was reduced by using fasting donors, by separating the plasma from stored blood rather than fresh blood, by dilution of the separated plasma to approximately the original blood volume with physiologic saline containing glucose, and by the addition of "merthiolate" to a final concentration of 1:10,000. In order to get rid of further precipitates or the usual fibrin "veil" which forms in aging plasma, it should be filtered at the time of transfusion.

The collected plasma should not show frank evidence of hemolysis; however, a greater degree of hemolysis may be tolerated if the plasma is to be used for immediate transfusion than if it is to be preserved. Unless plasma is used for immediate transfusion into a recipient of the same group as the donor, lots of plasmata should be pooled to suppress the activity of the isoagglutinins.

The methods employed by Scudder[5] in his wide experience with the Blood Betterment Association in collection of blood for the British, merit a detailed description: "Blood is drawn from voluntary donors into 235 Ml. centrifuge tubes; it is chilled in the refrigerator and placed in a chilled centrifuge (this is done by a cone holding dry ice, thereby obviating the expense of a cold centrifuge); the plasma is withdrawn by suction the next morning into a flask in which various plasmata are mixed. The bacteriologic study is immediately instituted, and should the report come back after 72 hours that the plasma is sterile, both as to aerobic and anaerobic tests, we then siphon off 500 cc. into Baxter plasmavacs of the 1,000 cc. variety. These flasks already have in them 500 cc. of physiologic salt solution. It is this mixture of plasma that we are sending to England." Satisfactory results have followed the use of plasma prepared in this manner. It should be stated, however, that Scudder[5] regards this as a makeshift procedure and is of the opinion that dried plasma is the answer to the problem.

Preservation.—Plasma may be preserved in one of three forms: (a) Liquid plasma; (b) dried plasma; and (c) concentrated liquid plasma. To date there seems little reason for exploiting the latter preparation as such, as it can be so readily prepared from dried plasma.

The preservation of *liquid plasma* by addition of "merthiolate" in a final concentration of 1:10,000 has been advocated by Strumia,[5] Elliott,[30] and

others; however, preliminary observations by Sturgis,[5] and by Scudder[5] indicate that merthiolate is not a reliable preservative for plasma which is kept at room temperature.

It has been shown that one is warranted in using sterile plasma which has been kept in a refrigerator for a number of weeks, but the evidence is less certain respecting plasma stored at room temperature. Admitting that refrigeration is preferable, Elliott, Busby and Tatum[30] administered 53 samples of plasma which had stood at room temperature for from one to 270 days, some of which had been transported by various conveyances for as much as 17,000 miles without encountering any untoward reaction. The preliminary observations of Sturgis,[5] and Scudder[5] are not so encouraging. The latter author[31] stated recently that the electrophoretic pattern of unrefrigerated stored plasma is not normal. Presumably some sort of gradual denaturation takes place in liquid plasma not kept at low temperature, although the extent of this, and the degree to which it renders the plasma unsuitable for transfusion has not been clearly defined. If the preservation of unrefrigerated plasma for indefinite periods becomes feasible, it will greatly reduce the necessity for dried plasma preparations.

Intensive study of *dried plasma* has been instituted recently in order to obtain a plasma product suitable for intravenous injection after long storage periods at uncontrolled temperatures. The available evidence indicates that desiccated plasma protected from moisture in a sealed container is suitable in this respect, making it a highly desirable product for use under conditions attending military operations in spite of the increased difficulty and cost of its preparation. It may be pertinent to remark here that the marketing of either liquid or dried plasma by commercial houses at a reasonable price is excluded by donor costs. It is only through agencies having volunteer donors that they may be supplied at a cost which is not prohibitive.

Many problems respecting the preservation of plasma by dehydration remain to be clarified, including (a) most economical means of preparation; (b) kind of, and conditions obtaining in the container of the dried product; (c) the need for Wassermann testing of donors, *i.e.*, the survival of spirochetes in the dried product; and (d) means of sterilizing the dried plasma so that previous manipulations need not be aseptic. These and many others are the subject of contemporary investigation. In respect to *methods* it might be apropos to briefly summarize the present position.

SUMMARY OF PRESENT METHODS TO PRESERVE DESICCATED PLASMA

Irrespective of what methods of desiccation are employed, the resulting product must be rapidly regenerable as a sterile protein solution whose original colloidal characteristics have not been materially altered. Inasmuch as in treating shock the primary aim is restoration of blood volume, preservation of the more labile components of plasma such as prothrombin, complement, *etc.*, is of secondary importance, although in the case of certain methods, notably those involving vacuum sublimation, these are unaffected.

Methods of producing such dried protein material may be roughly divided into three categories or combinations of these: (a) Simple evaporation; (b) vacuum desiccation;

and (c) dehydration without denaturation by organic solvents. Salt precipitations, *etc.*, may be involved in any of these processes. To date, the removal of water from native plasma or serum by vacuum processes appears to have been thoroughly studied. The earlier literature on this and upon certain other procedures has been summarized by Elser, Thomas and Steffen,[32] and by Flosdorf and Mudd.[33]

Vacuum sublimation of vapor from frozen plasma or serum, first described by Shackell,[34] appears to produce an almost ideal dried product. When the volumes of plasma dried are more than a few cubic centimeters, the volumes of vapor at the pressure of the system are so enormous as to demand an especially large pump capacity or installation of some particularly efficient means of removing the vapor within the system, thus lessening the load on the pump.

Several processes have recently been described in which the principle of vacuum sublimation is utilized, the plasma being either prefrozen, or frozen, by the heat loss by evaporation in the early stages of the process ("snap-freezing"), and the frozen state is thus maintained until dehydration is nearly completed without additional chilling; indeed, heat may be applied with advantage to prevent too great a fall in the temperature and, hence, the vapor pressure of the subliming solid:

(1) The "Lyophile Process," of Flosdorf and Mudd,[33] is an improvement of similar procedures of antecedent workers. (See also references 32 and 35). In this method the vapor is removed within the system by a condenser chilled with a solid CO_2-organic solvent mixture.

(2) The "Cryochem Process" (Flosdorf and Mudd[36]) employs anhydrous calcium sulphate to remove the vapor within the system by formation of the regenerable hemihydrate. Various chemical desiccants have been used by other investigators for the same purpose, including phosphorus pentoxide and sulphuric acid.

(3) The "Adtevac Process" (Hill and Pfeiffer[37]) utilizes chilled silica gel to adsorb the vapor in the system. The anhydrous gel may be readily regenerated for further use.

(4) The "Desivac Process" (Flosdorf, Stokes and Mudd[38]) permits the vapor to flow directly into the oil of a high vacuum pump, the oil in turn circulating through a continuously operating centrifuge which separates and removes the aqueous phase. Presumably the pump capacity is relatively large in order to remove the volume of vapor which is very great in spite of the fact that the operating pressure is somewhat higher than that of the other processes.

In all of these and other similar procedures the sterile plasma may be placed in the container from which it ultimately is to be dispensed, and attached to a manifold of the vacuum apparatus, or, after loose plugging, placed within the apparatus. In this way sepsis as a result of multiple transfer is avoided, and in the former procedure the container may be sealed *in vacuo* at the completion of the process before removal from the manifold. The dry product has a porous structure of considerable bulk and surface which readily goes into solution upon admission of a suitable quantity of sterile distilled water into the container. For this purpose and to facilitate dispensation various types of vaccine bottle stoppers have been employed, connection to the vacuum apparatus being made through these or by glass side-arms which may be sealed off separately with a blow torch.

The rate at which plasma can be desiccated by these vacuum sublimation procedures is a function largely of the size of the apparatus, *i.e.*, the number of vessels accommodated by the manifolds, condenser or adsorbent, and pump capacity. "Desivac" apparatus suitable for dehydration of 600 liters of plasma per week is now available.[39] Several hours, in any event, are required for the vapor transfer, and the apparatus required is rather expensive. The moisture content of the final product of these various products is usually 0.3 per cent, and may be reduced to a mere trace. An excellent discussion of vacuum sublimation is to be found in a recent paper of Greaves and Adair.[35]

In addition to the vacuum sublimation procedures, three other methods for plasma dehydration will be mentioned.

(1) Simple vacuum distillation may be employed to desiccate plasma as described

recently by Edwards, Kay and Davie,[40] and Harper, Essex and Osterberg.[41] The product from these and similar processes usually is a hard, slowly soluble, scaly mass which must be ground before readily going into solution, although the product of Harper, Essex and Osterberg is stated to be flaky and easily soluble. The avoidance of contamination and the prevention of denaturation are difficult problems when this method is used.

(2) Plasma may also be readily concentrated or dried by evaporation in a current of air from the fluid contained in collodion bags (Thalhimer[42]). The resulting product, in our experience, does not easily go back into solution without preliminary pulverization.

(3) Labile proteins may be dehydrated without denaturation, by brief precipitation at low temperature from organic solvents, such as acetone ethyl and methyl alcohol.[43, 44, 45, 46] The excess solvent is readily removed *in vacuo* leaving a powder or porous cake of protein which may be quickly reconstituted in its original form by addition of water and the salts removed by the process providing the precipitation process has been carefully controlled. We are unaware of any reports dealing with this procedure for preparation of dried human plasma or serum for subsequent transfusion, although it is being employed in the preparation of heterologous plasma fractions prepared experimentally for this purpose by Cohn, and his associates.[5] This method, providing it can be suitably controlled, should, in the opinion of the authors, afford the cheapest and most rapid means of preparing large amounts of plasma or serum powder. Its subsequent storage in vacuo, the requirement of saline or Ringer's solution for regeneration rather than distilled water, and the problem of maintenance of asepsis necessary only in the latter stages of the process, should hardly overweigh the advantages this approach would, superficially, appear to possess. A great many investigators are now engaged in the study of the problem of dried plasma preparations and undoubtedly rapid advances will be made.

Transport.—The method of transport of liquid plasma will depend to a considerable extent upon the ultimate findings in respect to its preservability under conditions of uncontrolled temperature. It would appear desirable that it be transported in the container from which it is to be dispensed, particularly when used in areas of military operation. It should be considered, that when a liter of liquid plasma is transported, approximately 950 Gm. of unnecessary water is carried along with the 80 Gm. of essential protein. This is not a trivial matter when air transport to distant scenes of operation is involved.

Once it is sealed in a suitable container, dried plasma may be transported without special precautions in respect to temperature control. As it is desirable, ordinarily, that it be shipped in the container from which it is to be dispensed, it is clear that the mass, but not the bulk, is reduced in comparison to transport of an equivalent amount of liquid plasma. For long distance air transport, shipping in fully packed containers might be advisable. If containers of water for resolution of the dried plasma must be shipped with it, the load upon transport is even greater than that imposed by liquid plasma.

Dispensation.—The dispensation of liquid plasma is an even simpler procedure than that for whole blood, and, when available, may be administered with no greater delay or facilities than in the case of injection of saline or glucose solution. It is, however, usually advisable to filter liquid plasma just prior to administration in order to remove any precipitate or fibrin veil which may have formed.

The dispensation of dried plasma involves merely one preliminary step—

that of dissolving the product in an appropriate quantity of distilled water, which either must accompany the dried plasma or be available at the site of the transfusion. This constitutes a real difficulty under field conditions, and it is because of this that the Medical Corps of the British Army prefers the liquid form. In a recent communication from Dr. John Fulton it is stated that for immediate transfusion following the chaos of bombing casualties a liquid plasma or serum has decided advantages. When properly prepared, the plasma powder dissolves within a minute or two. One of the advantages of dried plasma is that it may be reconstituted in a small volume of water if so desired, yielding a concentrated plasma which may be especially desirable in certain instances.[9, 17] When the dried plasma is stored in a vacuum bottle, equipped with a readily punctured rubber vaccine cap, reconstitution is particularly simple, the requisite water being introduced by means of a syringe and needle.

(3) SERUM

The problems encountered in respect to serum are identical with those of plasma except in relation to collection, and in the decreased fibrin with "veil" formation during storage of the liquid product. Inasmuch as the authors do not anticipate that serum shall be shown to have any advantages justifying its use *rather* than plasma, further consideration of this fluid will be omitted.

(4) ANIMAL PLASMA

An almost infinite supply of plasma would be available from lower animals could this be so modified as to be suitable for intravenous injection in man. Indeed, single transfusions of native animal plasma are often tolerated without ill effects[47, 16] although the procedure can, by no means, be considered a safe one. Contemporary attempts to modify animal plasma by Cohn,[45] and the observations of Wangensteen,[16] and of others in regard to this fundamental problem are encouraging and may possibly lead to dramatic advances in the field of plasma therapy.

SUMMARY

In the treatment of traumatic shock the primary objective is the restoration of a blood volume which has been reduced in consequence of hemorrhage, loss of plasma locally at the site of injury, or generally as a result of increased capillary permeability. Infusion of crystalloidal solutions only transiently increases the blood volume and may, eventually, still further reduce it. Only whole blood or plasma may safely, effectively, and permanently restore the volume of the circulation, and of these plasma is preferable because a unit volume supplies more osmotically active protein than does whole blood. The latter, usually, is essential only in the presence of profound anemia.

The more frequent use of transfusions of whole blood and plasma has resulted in improved treatment of injuries encountered in civil life. Valuable time, in emergencies, is saved by having preserved whole blood from universal donors, and plasma, which need not be typed, available in blood banks.

The problems related to the collection, preservation, transport, and dis-

pensation of whole blood and plasma have been discussed with special consideration of these in respect to military operations. The limitations of whole blood are accentuated under conditions of warfare, and the more readily preservable plasma is better adapted to cope with these complications. Particularly this is true of dried plasma which may be preserved indefinitely at uncontrolled temperatures. The length of time that sterile liquid plasma may be safely kept unrefrigerated is not yet satisfactorily established, and may be limited. In civil life dried plasma can be made available in communities remote from blood banks, or where direct whole blood transfusion is inconvenient or impractical. Dried plasma, however, has certain disadvantages both in civil and military surgery. Its preparation is expensive; sterile distilled water must be available where it is used or must accompany it; and some time, usually only a few minutes, is required for it to go into solution. This constitutes, however, a valid objection to its use in advanced military zones, since the liquid form may be administered with less delay and less equipment. Nevertheless, the dried form will remain superior to liquid plasma, all factors considered, until the problem of permanent preservation of the latter is solved.

Preliminary investigations related to the modification of animal plasma so that it may be suitable for intravenous injection are encouraging but have not yet progressed beyond an experimental stage.

It is our impression that the program of medical preparedness should include the organization of a number of well-equipped units in various cities throughout the country for the collection and preservation of whole blood and plasma. Emphasis should be placed upon the development of more efficient and less expensive means of preparing dried plasma, upon improving the preservation of liquid plasma; and, possibly, whole blood, and upon the development of animal plasma, or other protein substitutes for these. Even though the unhappy necessity of actively operating these centers for taking care of military casualties does not arise, the resulting improvement in availability of blood and plasma will result in a marked advance in the prompt and adequate treatment of shock in the civil practice of surgery.

BIBLIOGRAPHY

[1a] Blalock, Alfred: Experimental Shock. The Cause of the Low Blood Pressure Produced by Muscle Injury. Arch. Surg., 20, 959, 1930.

[1b] Blalock, Alfred: Principles of Surgical Care. Shock and Other Problems. St Louis, C. V. Mosby Company, 1940.

[2] Blalock, Alfred: Shock. Further Studies with Particular Reference to the Effects of Hemorrhage. Arch. Surg., 29, 837, 1934.

[3a] Beard, J. W., Blalock, A., *et al.*: Intravenous Injections. Jour. Clin. Invest., 11, 249–325, 1932.

[3b] Minot, A. S., and Blalock, A.: Plasma Loss in Severe Dehydration, Shock and Other Conditions as Affected by Therapy. ANNALS OF SURGERY, 112, 557, 1940.

[4] Amberson, W. R.: Blood Substitutes. Biol. Rev., 12, 48, 1937.

[5] Personal communication, 1940.

[6] Wood, G. O., and Blalock, A.: A Study of the Effects of Uncomplicated Hemocon-

centration (Erythrocytosis), with Particular Reference to Shock. Arch. Surg. In Press.

[7] Rous, P., and Wilson, G. W.: Fluid Substitutes for Transfusion After Hemorrhage. J.A.M.A., 70, 219, 1918.

[8] Johnson, G. S., and Blalock, A.: Experimental Shock. A Study of the Effects of the Loss of Whole Blood, of Blood Plasma and of Red Blood Cells. Arch. Surg., 22, 626, 1931.

[9] Bond, D. D., and Wright, D. G.: Treatment of Hemorrhage and Traumatic Shock by Intravenous Use of Lyophile Serum. ANNALS OF SURGERY, 107, 500, 1938.

[10] Mahoney, E. B.: Study of Experimental and Clinical Shock with Special Reference to Its Treatment by Intravenous Injection of Preserved Plasma. ANNALS OF SURGERY, 108, 178, 1938.

[11] Levinson, S. O., Neuwelt, F., and Necheles, H.: Human Serum as a Blood Substitute. J.A.M.A., 114, 455, 1940.

[12] Carrel, A., and Lindbergh, C. A.: The Culture of Whole Organs. Science (n.s.), 81, 621, 1935.

[13] Holman, R. L., Mahoney, E. B., and Whipple, G. H.: Blood Plasma Protein Given by Vein Utilized in Body Metabolism. II. A Dynamic Equilibrium Between Plasma and Tissue Proteins. Jour. Exp. Med., 59, 269, 1934.

[14] Pommerenke, W. T., Slavin, H. B., Kariher, D. H., and Whipple, G. H.: Dog Plasma Protein Given by Vein Utilized in Body Metabolism of Dog. Horse Plasma and Dog Hemoglobin Not Similarly Utilized. Jour. Exp. Med., 61, 283, 1935.

[15] Daft, F. S., Robscheit-Robbins, F. S., and Whipple, G. H.: Plasma Protein Given by Vein and Its Influence Upon Body Metabolism. Jour. Biol. Chem., 123, 87, 1938.

[16] Wangensteen, O. H., Hall, H., Kremen, A., and Stevens, B.: Intravenous Administration of Bovine and Human Plasma to Man: Proof of Utilization. Proc. Soc. Exp. Biol. and Med., 43, 616, 1940.

[17] Best, C. H., and Solandt, D. Y.: Concentrated Serum in Treatment of Traumatic and Histamine Shock in Experimental Animals. Brit. Med. Jour., 1, 799, 1940.

[18] Stevens, L. T., and Lee, F. S.: Quoted by Amberson.[4]

[19] Brodie, T. G.: The Perfusion of Surviving Organs. Jour. Physiol., 29, 266, 1903.

[20] O'Connor, J. M.: Über den Adrenalingehalt des Blutes. Arch. exp. Path. u. Pharmak., 67, 195, 1912.

[21] Strumia, M. M., Wagner, J. A., and Monaghan, J. F.: The Use of Citrated Plasma in the Treatment of Secondary Shock. J.A.M.A., 114, 1337, 1940.

[22] Strumia, M. M., Wagner, J. A., and Monaghan, J. F.: The Intravenous Use of Serum and Plasma, Fresh and Preserved. ANNALS OF SURGERY, 111, 623, 1940.

[23] Best, C. H., and Solandt, D. Y.: Use of Plasma or Serum as a Substitute for Whole Blood. Brit. Med. Jour., 2, 116, 1940.

[24] DeGowin, E. L., Harris, J. E., and Plass, E. D.:Studies on Preserved Human Blood. I. Various Factors Influencing Hemolysis. J.A.M.A., 114, 850, 1940.

[25] Scudder, J., Drew, C. R., Corcoran, D. R., and Bull, D. C.: Studies in Blood Preservation. J.A.M.A., 112, 2263, 1939.

[26] Bull, D. C., and Drew, C. R.: The Preservation of Blood. ANNALS OF SURGERY, 112, 498, 1940.

[27] DeGowin, E. L., Hardin, R. C., and Swanson, L. W.: Studies on Preserved Human Blood. IV. Transfusion of Cold Blood into Man. J.A.M.A., 114, 859, 1940.

[28] Rous, P., and Turner, J. R.: The Preservation of Living Red Blood Cells *in Vitro*. Methods of Preservation. Jour. Exp. Med., 23, 219, 1916.

[29] Mason, M. F., and Blalock, A.: Unpublished observations, 1940.

[30] Elliott, J., Busby, G. F., and Tatum, W. L.: Some Factors and Observations on Preparation and Preservation of Dilute Plasma. J.A.M.A., 115, 1006, 1940.

[31] Scudder, John: Studies in Blood Preservation. The Stability of Plasma Proteins. ANNALS OF SURGERY, 112, 502, 1940.

[32] Elser, W. J., Thomas, R. A., and Steffen, G. I.: The Desiccation of Sera and Other Biological Products (Including Microorganisms) in the Frozen State with the Preservation of the Original Qualities of Products So Treated. Jour. Immunol., 28, 433, 1935.

[33] Flosdorf, E. W., and Mudd, S.: Procedure and Apparatus for Preservation in "Lyophile" Form of Serum and Other Biological Substances. Jour. Immunol., 29, 389, 1935.

[34] Shackell, L. F.: An Improved Method of Desiccation, with Some Applications to Biological Problems. Amer. Jour. Phys., 24, 325, 1909.

[35] Greaves, R. I. N., and Adair, M. E.: High-Vacuum Condensation Drying of Proteins from the Frozen State. Jour. Hygiene, 39, 413, 1939.

[36] Flosdorf, E. W., and Mudd, S.: An Improved Procedure and Apparatus for Preservation of Sera, Microorganisms and Other Substances. The Cryochem-Process. Jour. Immunol., 34, 469, 1938.

[37] Hill, J. M., and Pfeiffer, D. C.: A New and Economical Desiccating Process Particularly Suitable for the Preparation of Concentrated Plasma or Serum for Intravenous Use: The Adtevac Process. Ann. Int. Med., 14, 201, 1940.

[38] Flosdorf, E. W., Stokes, F. J., and Mudd, S.: The Desivac Process for Drying from the Frozen State. J.A.M.A., 115, 1095, 1940.

[39] Stokes, F. J.: Personal communication, 1940.

[40] Edwards, F. R., Kay, J., and Davie, T. B.: The Preparation and Use of Dried Plasma for Transfusion. Brit. Med. Jour., 1, 377, 1940.

[41] Harper, S. B., Essex, H. E., and Osterberg, A. E.: The Preparation and Experimental Use of Dried Blood Plasma. Proc. Staff Meet. Mayo Clinic, 15, 689, October 30, 1940.

[42] Thalhimer, W.: A Simple, Inexpensive Method for Concentrating Serum under Sterile Conditions. Proc. Soc. Exp. Biol. and Med., 37, 639, 1938.

[43] Mellanby, J.: Diphtheria Antitoxin. Proc. Roy. Soc. (London), B, 80, 399, 1908.

[44] Ferry, R. M., Cohn, E. J., and Newman, E. S.: Studies in the Physical Chemistry of the Proteins. XIII. The Solvent Action of Sodium Chloride on Egg Albumin in 25 per cent Ethanol at −5°. Jour Am. Chem. Soc., 58, 2370, 1936.

[45] Cohn, E. J., Luetscher, J. A., Oncley, J. L., Armstrong, S. H., and Davis, B. D.: Preparation and Properties of Serum and Plasma Proteins. III. Size and Charge of Tractions Separating upon Equilibration Across Membranes with Ethanol-Water Mixtures of Controlled pH, Ionic Strength and Temperature. Jour. Am. Chem. Soc. In Press.

[46] Schmidt, C. L. A.: The Chemistry of the Amino Acids and Proteins. Baltimore, Charles C. Thomas, 1938, p. 280, *et seq.*

[47] Lower and King: Phil. Trans., 2, 557, 1667.

DISCUSSION.—DR. ROY D. MCCLURE (Detroit, Mich.): I am very glad, at Doctor Blalock's request, to tell you of the method of desiccating blood plasma, now successfully in use at the Henry Ford Hospital. Dr. Frank W. Hartman, Director of our laboratory, did not at first start to make dried plasma. He was trying to eliminate reactions following intravenous therapy due to impure rubber, or dirty tubing.* He conceived the idea of using cellophane tubing instead of rubber. He first used tubing made for dialysis but later obtained the tubing prepared for sausage casings, and it has proved satisfactory in our now extensive experience. This tubing has the advantage of compactness. In a small bottle, it is sterilized under steam pressure, and is thrown away when we have used it once.

Doctor Hartman then tried cellophane bottles. Fluid, however, was lost rather rapidly through their walls. This loss was through osmosis and not

* Hartman, F. W.: The Elimination of Rubber Tubing on Intravenous Sets, ANNALS OF SURGERY, 111, 498–501, March, 1940.

due to filtration. It then occurred to him that desiccated blood plasma could be prepared by using this principle. (Slide) (This diagrammatic representation is published in the current issue of the J.A.M.A., Dec. 7, 1940, Vol. 115, pp. 1989–1990, by Doctor Hartman.) He now makes large double walled cellophane cylindrical tubing 16 and 24 inches in length. Between these two walls of cellophane the blood plasma is poured with a quantity of filtered air. A number of these cylinders are supported between the rims of two wheels, mounted on the same axle, at a suitable distance. A large fan at one side circulates the air through the center and around the outside of each cylinder as the wheels are turned by a small motor (rotor-pervaporator). This rotation produces foaming and the end-product is a light airy material which may be readily broken up (Fig. 1). Plasma desiccated in this manner is readily regenerated when we wish to use it. In emergency, we may regenerate it in the same cellophane containers either by immersing the cylinder in distilled water or by opening the same and adding distilled water.



FIG. 1.—Cellophane cylinder containing foamy, desiccated plasma.

We have used this powder in our operating rooms now for some months, and it has proved very satisfactory. We know that this method is a satisfactory one for drying plasma. It has an advantage in the rapidity of desiccation, solubility of the product, and low cost.

DR. WALTMAN WALTERS (Rochester, Minn.): Two years ago, while on a visit to European clinics, it was interesting to find that in the Serum Institute, in Copenhagen, the Director had instituted a method by which the blood-group of each soldier was recorded on his name plate. In view of the fact that blood is being drawn from recruits for complement fixation tests, it would be an easy matter to have the blood grouped and the result placed on the proper identification plates. The advantage of that would be apparent in the field, where blood transfusion could be carried out immediately. It should be possible to train large numbers of persons, both in the medical corps and in the line, to draw blood and reinject it, provided suitable containers were always available. Transfusions of blood serum and plasma have been of great value. Why not draw 200 to 500 cc. of blood from each recruit, dry the plasma and store it for use when necessary? It would seem that the method of drying blood plasma for transportation and storage will probably be of great advantage in war casualties.

In recent issues of "The Military Surgeon"* there were several excellent articles,[1, 2, 3] translated from the German, about the transportation of the

*[1] Hipple, Major General Erich: Transport by Air of the Sick and Wounded. Mil. Surg., 86, 439–444, May, 1940.

[2] Tönnis, W.: Air Transportation of the Sick and Wounded a Medical Problem. Mil. Surg., 87, 22–25, July, 1940.

[3] Schmidt, Staff Surg. Frederick: Transportation of the Wounded by Plane. Mil. Surg., 87, 136–141, August, 1940.

wounded by air. One cannot but be impressed by the effect of the difference in the concentration of oxygen and nitrogen on patients with chest and abdominal injuries who are being flown at high altitudes. It should not be difficult, with the pressure chambers now being built, for cheap chambers to be obtained to study these problems on animals. It seems to me, too, that it would be well worth while to send men to the various institutions in Canada where research is being carried out in connection with war medical problems for suggestions relative to investigative problems in war medicine.

I should like, again, to call attention to a worth while suggestion—the routine grouping of blood on all recruits, with the group placed on their identification name plates.

DR. BRADLEY L. COLEY (New York, N. Y.): I thought you might be interested in actual accounts of British opinion regarding the use of plasma and serum for war victims. At the request of Dr. C. P. Rhoads, of the Plasma Division of the Blood Transfusion Betterment Association, I put some questions to Professor G. Grey-Turner, of the British Post-Graduate Medical School, and to Dr. Philip D. Wilson, Director of the American Hospital in Britain, and through these men I received replies from Sir E. Mellanby, of the Medical Research Council, and Janet Vaughan, Medical Officer in Charge of the Ministry of Health and Medical Research Council. The former made the following statement:

"The British reserves of donors have not been exhausted; in point of fact they have been scarcely tapped. The national transfusion scheme is not yet under way, and it is doubtful if it will be in full swing before the New Year. The four depots near London, administered by the Medical Research Council, are the only units bleeding steadily, and they anticipate there will be no difficulty in keeping up their present rate of bleeding for some months.

"The preference is for dried serum. The reasons for this are:

(1) That serum can be bacteriologically filtered through Seitz pads.

(2) That the dried product keeps indefinitely.

(3) That if a chance organism gets in during the process, there is no opportunity for this to grow and produce toxins.

(4) It can be produced without the addition of an antiseptic.

(5) There is no evidence that it is a 'toxic fluid.'

"On the other hand, citrate plasma has the following disadvantages:

(1) It clots after filtration through Seitz pads.

(2) If it is issued without being filtered, it is opalescent and subsequent infection cannot be detected.

(3) That there is a suspicion that after some time the antiseptic action of merthiolate dies out, and that organisms, if present, begin to grow.

(4) That reports are coming in of brisk reactions after plasma, due presumably to using infected plasma.

"During the air raids on London during September, it may be assumed that approximately 1,500 casualties were transfused, the majority with plasma. The amount given to each patient varied from 1,000 to 2,500 cc."

I was surprised at the large amount of plasma required for each patient, but this was substantiated by a letter from Janet Vaughan, as follows:

"Recent figures from the Middlesex Hospital are: 130 air raid casualties; 22 needed transfusion; average dose four and one-half bottles of plasma.

"(1) We really need plasma sent from the U.S.A. It is not merely a question of apparatus.

"(2) Our supplies of donors are not exhausted, they are constantly

growing, but in view of the large quantities needed by each casualty, four and seven pints as a minimum, very large amounts of plasma are needed.

"(3) We prefer dried serum to liquid plasma for some purposes—

(a) Ease of transport, and lack of necessity for refrigeration.

(b) It is much easier to make sterile dried serum than it is to make sterile liquid plasma. Dried plasma is not used because preparation is unsatisfactory.

"(4) I cannot give precise figures as to the numbers of transfusions of plasma given in the last few months in the whole country, but all the available plasma has been used. I have issued for use in the N.W. London area 1,238 bottles since August 1st. All reports on the use of plasma are most enthusiastic."

DR. ALFRED BLALOCK (Nashville, Tenn., closing): Doctors Hartman and McClure are to be complimented on their excellent work. This modification of the cellophane method is a real advance; and if this powder can be restored to the liquid form readily, and if it is sterile and not denatured, it will probably be used very extensively.

Aside from the military aspects, it is obvious that the ready availability of whole blood in banks, and of liquid or dried plasma, will result in the more frequent use of these solutions. It should be generally recognized that these solutions should be used for the prevention of the decline in blood pressure as well as for treating shock that has already developed. Blood or blood substitutes should be available for immediate administration in all major operative procedures in which the need for supplementing the blood volume might arise.

The custom of administering one pint of blood in the prevention or treatment of shock is too prevalent. It apparently arose from the fact that a donor may give one pint of blood with no danger and little inconvenience. It is important that blood should be given in adequate amounts according to the needs of the patient. If one pint does not suffice, that does not mean that several pints might not save the patient.

PERIPHERAL VASCULAR INJURIES*

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Peripheral Vascular Injuries frequently involve both artery and vein but the arterial injury is more important, for, due to the high arterial pressure, hemorrhage is more profuse and more difficult to control. Furthermore, obstruction to the flow of blood through a main artery is more apt to produce serious damage to the tissues than is obstruction of the return flow in the concomitant vein. When a large vessel of the trunk, either artery or vein, is injured, fatal hemorrhage frequently occurs because the vascular wound usually communicates directly with one of the body cavities. Perforation of a large peripheral vein usually communicates with the surface by a narrow channel and, therefore, results in only moderate blood loss, for shifting of the muscle planes obliterates this channel and traps the blood in the tissues. This produces a rapid rise in the extravascular pressure and prevents further bleeding. Bleeding from a peripheral artery may be controlled in the same way, but a higher extravascular pressure is necessary to control arterial bleeding and this may produce serious obstruction to blood flow distal to the injury. As the extravascular pressure rises it first obstructs the veins, then the arteries, including the collateral channels. The absence of pulsation in the small vessels and the increased pressure at the level of injury result in lymph stasis and edema. The edema causes further interference with the circulation, so the net result is the establishment of a vicious circle which leads to gangrene unless the pressure on the collateral channels is promptly relieved.

This sequence of events illustrates one way in which serious difficulty may arise as the result of injury to a major peripheral artery. There are many other possibilities, such as ischemic gangrene from obstruction of important vessels which have insufficient collaterals—for example, the popliteal arteries—the development of false aneurysms, *etc.*

It is essential, therefore, that surgeons be aware of the physiologic and pathologic sequelae common to vascular injuries as well as the specific sequelae likely to result from wounds of certain vessels. It is also necessary that they be familiar with the symptoms and signs associated with such sequelae.

Fortunately, the evidence necessary for the diagnosis of wounds of the larger arteries may be obtained by careful physical examination, without the use of complex apparatus. The area adjacent to the wound should be examined for evidence of massive infiltration of the tissues with blood and for pulsation outside of the line of the artery. The vessels distal to the injury should be palpated and the volume of the pulse compared with that of the

* Presented before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 1940.

pulse in the corresponding vessels on the opposite and uninjured side. The superficial veins should be inspected and the levels at which these veins are full and collapsed should be compared with similar levels in the sound extremity. Also, the surface temperature and color in the two extremities should be compared. Finally, the area over the main vessels near the wound should be auscultated. Although the signs of vascular injury usually are not difficult to demonstrate, they may be obscured in the presence of profound shock. Furthermore, there are often progressive changes in the physical signs, so examination as outlined above should be repeated if the original evidence is inconclusive.

The treatment of vascular injuries depends upon many factors such as the vessel injured, the presence of persistent or recurrent hemorrhage, the condition of the distal circulation, the general condition of the patient, and the available facilities. Immediate steps to control hemorrhage should be taken if there is active bleeding when the patient reaches a First Aid Station. This would seem obvious. However, the desirability of avoiding further trauma in the presence of shock has been so emphasized, that it now seems advisable to stress the necessity for the immediate control of active hemorrhage even in the presence of severe shock. Bleeding from large vessels may be controlled by the application of ligatures, by digital pressure, or by a tourniquet. If the vessel is exposed by extensive destruction of the overlying tissues, it should be doubly ligated and divided between the ligatures. When a narrow tract connects the wound in an artery with the surface, strong digital pressure over the artery at the site of injury may permit the formation of a clot which will control bleeding until the patient can be transferred to a station with adequate facilities for surgery. If the wound involves an extremity, a tourniquet should be applied proximal to the wound during such transfer; but the tourniquet should not be tightened unless hemorrhage recurs. The tourniquet should be used only when hemorrhage cannot be controlled by other means. If there is no alternative, a patient may be transferred from one station to another with a tourniquet in use. However, the transfer must be made as rapidly as possible and a sign should be attached to the patient's clothing calling attention to the presence of a tourniquet, so that it will be removed and hemorrhage controlled by other means at the earliest possible moment. If a tourniquet is employed too long, gangrene is inevitable.

When a patient with injury to a major vessel reaches a station with adequate facilities for surgical intervention, the decision must be made as to whether or not immediate operation is indicated. Early operation is indicated if there is continued or recurrent bleeding, inadequate circulation distal to the wound, or if there is a large amount of devitalized tissue. If there is massive local swelling and poor circulation beyond, exploration should be undertaken, and as much clot evacuated as possible. The wounded artery should be inspected to determine whether it is amenable to repair or requires ligation. Even though the artery has to be ligated, the circulation will usually be improved by the relief of pressure on the collateral channels. However,

if there is no bleeding and no reason to suspect that organic material, such as shreds of clothing, has been carried in with the missile, and if the circulation distal to the point of injury is satisfactory, it may be advisable to delay operation. Superficial infection is an indication for delay because the entire operative field is apt to become infected if operation is performed under such circumstances, whereas if proper conservative measures are employed this is unlikely. Diffuse pulsation in the region around the wound is not necessarily an indication for early operation, for pulsating hematomata may heal spontaneously. They may become localized and converted into false arterial aneurysms or arteriovenous aneurysms, depending upon whether the wound involves the artery alone or the artery and vein. Direct arteriovenous connections, without associated pulsating hematomata, may heal or may persist as arteriovenous fistulae (aneurysmal varices). When any of these conditions are present, and the distal circulation is adequate, operation should be delayed for two or three months, unless some indication for immediate interference, such as secondary hemorrhage, arises. Such delay permits improvement of the collateral circulation and gives time for the disappearance of pathogenic organisms from the adjacent tissues.

Whether or not immediate operation is decided upon, shock should be controlled, and when possible the blood volume and cell content should be restored.

If secondary hemorrhage occurs, it is necessary to expose the wound in the artery and repair it or ligate the vessel. If suture is not feasible, heavy silk ligatures should be applied both proximal and distal to the vascular wound, and the vessel divided between them. Proximal ligation of the artery at a distance from the wound is usually contraindicated when the artery alone is injured, and should never be undertaken when there is a communicating wound between the artery and vein.

Vascular suture, with maintenance of the lumen of the main artery, is the ideal procedure, but in World War I this was not often feasible. Such may also be the case in the present war for, as pointed out by Bernheim,[1] and others, the press of patients is so great and contaminations are of such common occurrence during active fighting, that the more refined surgical procedures have to be replaced by others more crude but life-saving to a greater number. The following objections have been advanced against suture: (1) It is more time-consuming and, because of the necessity for prolonged anesthesia, is probably more shocking than ligation; (2) it requires more refined instruments and suture material, which are not always available; (3) if gross infection occurs, the danger of secondary hemorrhage is increased; and (4) in many instances the vascular damage is so extensive that direct suture is not practical, and venous transplants have not often been successful. However, with the present methods of warfare there will probably be an increased incidence of vascular wounds made by small fragments of metal—such small wounds being most suitable for repair. Furthermore, the production of clinically effective heparin has increased the chances of success in end-to-end

suture. Murray and Best[2] have shown that with regional heparinization, 80 per cent of vessels remained patent following end-to-end suture, and 70 per cent remained patent when venous transplants were used. While regional heparinization seems to have a number of advantages over the systemic use of this substance, the latter should be employed when, for any reason, regional administration is not feasible. Since thrombosis at the suture line may usually be prevented by the use of heparin, and the incidence of infection reduced by chemotherapy, it would seem wise to suture wounds of such arteries as the carotid, popliteal, and common femoral, because there is danger of ischemic gangrene when these arteries are suddenly occluded. Success in this type of vascular surgery requires a high degree of technical skill even with the aid of heparin. Since the incidence of vascular injuries is small in civilian practice, surgeons should perfect their technic in vascular suture in the experimental laboratory.

The danger of severe infection and secondary hemorrhage is reduced by the systemic and local use of the sulfonamide derivatives. We believe that this is particularly true of the local application of sulfanilamide which we have now employed for three years in all obviously contaminated wounds. Unfortunately, I have not had the opportunity to make a careful study of our records in these cases, but I am convinced that the incidence of infection is reduced to a greater degree than can be explained on the basis of systemic absorption of the drug. The only objection to the local use of sulfanilamide powder, of which I am aware, is that it increases bleeding. In our experience this has not been important. We, therefore, advocate the local application of sulfanilamide in contaminated wounds, urging, also, that other measures, such as débridement, be carried out with meticulous care.

When suture of an artery is not feasible, ligatures must be applied and the vessel divided between them. Catgut is usually recommended for ligatures when there is active infection, but I agree with Reid[3] that silk is especially indicated under such circumstances, and that large ligatures should be used for large arteries, as the larger ligatures are less likely to cut through.

Ischemic gangrene is particularly apt to follow sudden obstruction of the popliteal, common femoral, carotid, and axillary arteries. It is, therefore, essential when one of these arteries is obstructed that every precaution be taken to prevent circulatory insufficiency. The following measures, discussed in the order of their importance, should be considered in this connection, as any or all of them may be applicable in a given case:

(1) *Sympathetic Nerve Block.*—Blocking of the sympathetic nerves to the involved area, as suggested by Gage and Ochsner,[4] and their associates, is probably the most important measure yet recommended for the improvement of the collateral circulation after the sudden occlusion of an important artery. It relaxes the spasm of the branches of the obstructed vessel and thereby increases the blood flow through the ischemic area. It may be accomplished (a) by the injection of novocain; (b) by the injection of alcohol; or (c) by operation, which is usually unnecessary. The injection of novocain, repeated

as often as is necessary, is usually the method of choice in patients with acute obstruction of otherwise normal vessels. In elective ligation the sympathetic nerves should be blocked both before and after operation, and in accidental occlusion of an artery they should be blocked as soon afterward as possible.

(2) *Prevention and Control of Infection.*—The extent of the associated injury and the occurrence of infection are important in determining the incidence of gangrene following vascular occlusion. In large wounds infection becomes more serious but the extent of the original injury, of course, cannot be controlled. It is essential that all available measures be employed to prevent infection by the usual pyogenic organisms and especially by the gas-forming anaerobes. The measures especially indicated are careful cleansing with warm normal saline solution, careful débridement, avoidance of tension if closure is attempted, and leaving the wound open if there is infection, local and systemic use of the sulfonamide derivatives, and administration of gas bacillus antitoxin. Blood replacement also helps to prevent infection.

(3) *Occlusion of the Concomitant Vein.*—Makins[5] established the value of this procedure in clinical cases, and Brooks and Martin,[6] Holman and Edwards,[7] and others, have demonstrated its effectiveness in experimental animals. The reasons for this are not clear, for Brooks and Martin have shown that obstruction of the concomitant vein, after obstruction of the artery, further decreases the volume flow of blood through the tissues distal to the occlusion, but they suggested that there was probably a better distribution of the blood going through. Holman and Edwards demonstrated that there was a higher intravascular pressure distally, and a greater increase in the minute volume-flow of blood from the distal end of a divided artery when the accompanying vein was ligated proximal to the arterial occlusion, than when the vein was obstructed at the same level as the artery. They, therefore, advocated ligation of the iliac vein when it was necessary to tie the femoral or popliteal artery. While the rationale of concomitant vein ligation is not clear, there seems to be little doubt of its effectiveness in reducing the incidence of ischemic gangrene, and since it apparently produces no important undesirable after-effects, it is indicated when such arteries as the femoral and popliteal are occluded.

(4) *Position of Involved Extremity.*—Rest and elevation of the affected extremity are so commonly observed in the treatment of thrombophlebitis that many physicians have adopted these measures in the treatment of all vascular disorders. Rest is a necessary measure following arterial occlusion, as muscular exertion increases the oxygen demand, but constant elevation of the part is obviously contraindicated in most instances of arterial occlusion. As suggested by Reid,[8] the extremity should be placed at a level at which the veins are normally full. Alternate elevation and depression of the extremity may be indicated when there is edema.

(5) *Avoidance of Undue Pressure.*—Tight circular dressings must be avoided, as they interfere with the flow through the collateral vessels, and

especial care should be exercised to avoid prolonged local pressure—as, for example, over the heel or external malleolus.

(6) *Local Temperature Control.*—An attempt should be made to maintain the temperature of the part at the normal level. This is probably best accomplished by the application of voluminous dressings of some warm, soft material such as cotton wool. External heat should be applied with care, and moist heat must be avoided.

(7) *Pavaex Machine.*—Generally speaking, the Pavaex machine is contraindicated when there is an extensive wound, and must not be employed in the presence of active infection. It is of no value when arteries are obstructed so near the trunk that the cuff cannot be applied proximal to the obstruction. When the arterial lesion is sufficiently distal, the Pavaex machine may be used, provided there are no contraindications such as wound infection.

(8) *Other Measures.*—As previously stated, the blood volume and cell content should be restored when possible, for this not only aids in the prevention and control of infection but also increases the amount of oxygen reaching the tissues. In other words, local anemia is accentuated by general anemia, and to some extent is relieved by blood replacement. In this connection, if there is cyanosis due to associated thoracic injury or pulmonary infection, an attempt should be made to relieve it by the administration of a high concentration of oxygen.

Satisfactory vasodilator drugs are not available. Nicotinic acid apparently has some value. Papaverin is rather widely used but its effect is uncertain.

CONCLUSIONS

The treatment of injuries to the major peripheral vessels forms an important part of modern war surgery. In the past, even during the World War I, vascular suture was not often feasible, and ligation, either immediate or delayed, was the usual method of treatment. Since we now have more effective means of preventing thrombosis at the line of suture, and of combating infection, suture should play a more important rôle in the treatment of vascular injuries. The incidence of peripheral gangrene should, thereby, be materially reduced.

When important arteries are occluded certain measures should be employed to combat ischemia, among them ligation of the concomitant vein or veins and sympathetic nerve block. The latter is especially valuable and should be undertaken immediately if there is any evidence of insufficient collateral circulation. In addition to these local measures, certain general measures must also be given consideration. The most important of these is blood replacement.

REFERENCES

[1] Bernheim, Bertram M.: Surg., Gynec., and Obstet., 30, 564, 1920.
[2] Murray, Gordon D. W., and Best, Charles H.: Annals of Surgery, 108, 163, 1938.
[3] Reid, Mont R.: Surg., Gynec., and Obstet., 58, 287, 1934.
[4] Gage, Mims, and Ochsner, Alton: Arch. Surg., 112, 938, 1940.

[5] Makins, George H.: Gunshot Injuries to the Blood Vessels. John Wright and Sons, Ltd. Bristol, 1919.
[6] Brooks, Barney, and Martin, K. A.: J.A.M.A., 80, 1678, 1923.
[7] Holman, Emile, and Edwards, Muriel E.: J.A.M.A., 88, 909, 1927.
[8] Reid, Mont R.: Am. Jour. Surg., 24, 11, 1934.

DISCUSSION.—DR. JOHN W. PRICE (Louisville, Ky.): There are one or two points I want to speak about. The first one is that I cannot share his enthusiasm for the operation of suturing blood vessels. I had been suturing blood vessels in the laboratory for eight years; and during my entire service in the war, in Evacuation Hospitals Nos. 1, 7, and 15, I did not have an opportunity to suture one vessel. I did have an opportunity to tie every large peripheral vessel, and I had no trouble in doing so.

I think many a boy lost an arm or a leg in the last war because a tourniquet was applied in the field by an enlisted man. In many cases the hemorrhage could have been controlled by a pack of gauze and a light bandage instead of a tourniquet. In the coming war I hope that more attention will be given to this point.

DR. DERYL HART (Durham, N. C.): In my opinion proximal ligation should be used only where it is impossible, or inadvisable, as in an infected wound, to expose the damaged point in the vessel, and where proximal ligation may be a life-saving procedure. I am sure Doctor Bigger agrees with this, and I simply wish to emphasize this point. My only experience with proximal ligation has been in the capacity of a consultant whose advice, to explore and suture the perforation of the femoral artery or to ligate the artery just proximal and distal to the injury, was ignored. The surgeon felt that it was simpler to undertake a proximal ligation in Scarpa's triangle, instead of exploring the vessel in Hunter's canal, with the tissues extensively infiltrated with blood. This operation was followed by a rapidly developing gangrene, which was made more likely by the following conditions:

(1) The continuity of the patent artery was interrupted at two well-separated points, thus requiring a much wider bridge of collateral circulation to carry blood from the artery proximal to the ligation to the extremity distal to the point of injury.

(2) The leak in the artery was not closed (except possibly by the blood clot, extravasation of blood, and tension beneath the fascia) so continued leakage of blood may have made it impossible for the collateral circulation to maintain sufficient pressure in the peripheral arterial system to keep the tissues alive.

(3) The blood clot was not evacuated and the tension beneath the deep fascia was not relieved, so that the resultant compression of the collateral vessels interfered seriously with the development of an adequate collateral circulation.

(4) With an initial adequate collateral circulation the continual extravasation of blood from the injured artery might still further increase the tension beneath the fascia and render these collateral routes inadequate.

In view of these factors it seems imperative that if ligation is necessary it should be performed, if at all feasible, immediately proximal and distal to the point of injury, without any intervening tributary vessels.

DR. ALTON OCHSNER (New Orleans, La.): I want to emphasize the importance of the abolition of the vasoconstrictor impulses in lesions of the peripheral arteries, which Doctor Bigger has referred to. Doctor Gage, of

our Clinic, has done a great deal of work on this, and has shown that if this is undertaken as a preliminary measure, ischemic gangrene in the extremities need not be feared in operations upon the peripheral vessels. Several years ago, Doctor Gage reported, before this Association, a case in which a mycotic aneurysm of the common iliac artery was successfully ligated without any disturbance of the vascularity of the extremity. This was made possible by a preliminary blocking with alcohol of the lumber sympathetic ganglia on the side. In patients with injuries of the peripheral arteries, vasospasm is an important factor in producing ischemia. This can be satisfactorily treated by abolishing the vasoconstrictor impulses by novocain block of the sympathetic ganglia. The greater the degree of trauma the more urgent the need for the sympathetic block. Even in peripheral arterial embolism, the removal of the associated vasospasm in the collaterals will overcome the ischemia, and embolectomy is seldom if ever necessary.

As a result of Doctor DeBakey's and my investigations in thromophlebitis, we are convinced that the vasospastic influences originating in an injured or inflamed portion of the vascular system produce spasm of the associated collaterals, particularly the arterioles, resulting in interference with the blood supply. This may be so severe that ischemic gangrene can result. All of these manifestations can be prevented and satisfactorily treated by either repeated novocain block of the lumbar sympathetic ganglia or an alcoholic block which produces a more lasting dilation.

DR. JOHN C. A. GERSTER (New York City): I would like to call attention to the possibility of secondary hemorrhage after ligation of main vessels in the presence of infection—no matter how mild—as most likely to occur from the seventh to the tenth day after ligation.

In Billroth's Clinic, in preantiseptic days, this fact was so well known that tourniquets were provisionally placed during these critical days so they might be instantly tightened in the event of secondary hemorrhage.

DR. I. A. BIGGER (Richmond, Va., closing): Doctor Hart apparently misunderstood my statements with regard to proximal ligation. I stated that proximal ligation, at a distance, should rarely be performed when the artery alone is injured, and never when there is a communicating wound between the artery and vein. I can conceive of circumstances under which proximal ligation may be advisable, but it certainly is not to be undertaken unless there is an excellent reason for doing so.

Vascular suture was not often feasible in the last war, and this may be true during the present war, but the opportunity for suture should be greater now.

The time to employ sympathetic block is prior to occlusion in elective cases, and at the earliest possible moment after accidental occlusion.

UROGENITAL INJURIES*

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A DISCUSSION of the urogenital injuries occurring in the present war is necessarily a brief and a theoretic one, for as yet there have been absolutely no reports of this subject in any of the very few foreign periodicals that are being received in this country to-day, but I believe the knowledge that we do have of the type of this conflict will allow us to rather accurately visualize the probable nature and frequency of the genito-urinary war injuries at this time. Whether such an analysis will be of value when and if we take an active part is questionable, for the method of combat and the methods of producing casualties are changing very rapidly.

As a result of the experience of urologists during the last war, some very definite statistical information dealing with the frequency and type of urologic injuries in war was obtained. It appears that approximately 7 per cent of all penetrating abdominal wounds were accompanied by renal damage, and that in 4 per cent the bladder was ruptured. Ureteral injuries were of great rarity. Doctor Young states that wounds of the external genitalia were far more frequent than those of any other portion of the genito-urinary tract, there being 164 cases in the Service records of the A.E.F. Due to the necessary delay in diagnosis and treatment of the injured, as well as the almost universal presence of accompanying damage to other parts of the anatomy, we would expect these cases would show a very high mortality, but it is surprising that as many as 61 per cent of the bladder cases died, and 25 per cent of the kidney cases were fatal. Even in those cases where the injury was confined to the external genitalia 2.3 per cent died. This is, apparently, a rather high mortality, and one that should be given serious thought.

Injuries of these organs are of such a serious nature that the individuals so affected, be they civilian or members of the armed forces, immediately become factors that interfere with the efficiency of the military action, whether that be offensive or defensive.

Military efficiency demands their prompt evacuation to a nonmilitary area. Humanitarian principles demand their prompt arrival in such areas, for it is only in such areas that the special services necessary for complete diagnosis and correct therapy can be maintained upon a basis of permanency sufficient to assure efficiency.

Due consideration to these facts should materially lower the mortality statistics previously mentioned. This problem of prompt evacuation of major casualties is undoubtedly being intensely studied by the Surgeon-General's office.

*Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

The accuracy of the previously mentioned incidence rates, which have been compiled by well known authorities cannot be questioned, but I doubt if they are of any particular value to those who are charged with the responsibility of the urologic injuries occurring in the present conflict, for this war is different, as different from the last as the last was from the Crusades.

It is to be remembered that during the last war combat was of a rather personal nature—more or less man-to-man—and that, broadly speaking, casualties were the result of penetrating wounds such as those produced by bullets and shell fragments. Casualties were confined almost entirely to those of the armed forces. But now, combat, if you can call it such, is a rather one-sided affair, ultramechanized units of one nation preying upon the civilian population of the other. On only rare occasions do the men of the armed forces actually fight each other. I should imagine that to-day the civilian casualty list is far greater than that of the armed forces.

Casualties are now produced in an entirely different way than they were 25 years ago, for now, during this period of ultramechanization, the damaging factor is massive, crushing force rather than the penetration by bullets or shell fragments. Consequently I feel that we are warranted in believing that the injured who do not immediately die are usually very seriously hurt. Hence, we should expect a marked increase in the severity and probably in the frequency of such things as ruptured kidneys and bladders. Casualties in the military service, itself, are probably more extensive and serious than in any other war, for if you can get a ruptured kidney or bladder as the result of an automobile "turn over," visualize just what would happen to you if you were in a tank or airplane?

In other words, I believe that the type of genito-urinary injuries occurring in to-day's conflict are quite comparable to those which we are seeing in our civilian practice with greater frequency each year, as the result of the constantly increasing number of automobile accidents. From the experiences gained in the Urologic Services connected with our larger general hospitals, where a great deal of traumatic urology is seen, certain lessons have been learned and certain basic principles established which, I think, may be easily applied to the conditions that are being seen in Europe to-day, and to which we, as doctors, may be required to give our personal attention in the not far distant future.

The most logical classification of renal damage is that of Stirling, who recognizes four groups: (1) In which there is minimal damage, with minor hemorrhage,a slight tearing of the renal capsule, and little or no damage to the renal parenchyma; (2) one or all of these are more severe; both of these types respond to conservative therapy. (3) There is actual major damage to the renal parenchyma, fracture of the capsule and massive hemorrhage both extracapsular and intrarenal. It is in this type that our therapeutic principles have materially changed during the past few years, for formerly we were inclined to treat these cases very conservatively, and many times were apparently successful.

A study of those cases that were supposedly handled successfully by conservative measures, and the results of Stirling, in his animal experimentation, have shown that the functional integrity of a third degree damaged kidney is frequently jeopardized, if not actually destroyed, by conservatism. It is now generally agreed that such a kidney should be exposed by a flank incision, the clot evacuated, hemorrhage controlled, and any definitely indicated reparative surgery carried out. (4) Damage is so extensive that the life of the individual can be best assured by prompt nephrectomy.

In ureteral injuries, immediate recognition of the nature of the injury is demanded in order that pyelotomy may be performed, and thus save a kidney until such time as plastic ureteral surgery can be safely undertaken.

Air-raid casualties among the civilian population will, I am certain, show a marked increase in the incidence of bladder rupture, particularly of the intraperitoneal type. Rupture of the bladder, whether it be of the extra- or intraperitoneal type, requires prompt recognition and immediate cystotomy. This is likewise true in cases of urethral rupture.

Efficient therapy of injuries of the urinary tract demands full recognition of the necessity of maintaining an unobstructed flow of urine from all parts of the tract, even if surgery is necessary to establish such drainage. Hemorrhage, of course, must be controlled, and its effects overcome by prompt utilization of to-day's accepted procedures.

Organs of the genital tract of the male may be treated conservatively, if infection is controlled, for the reparative ability of that part of the anatomy is well known.

As in all traumatic surgery the control of infection is a matter of major importance in the therapy of urogenital injuries. The remarkable advance of chemotherapy, during the past two or three years, has greatly increased our ability to deal with this problem of infection. The use of sulfanilamide as an irrigating solution, dilute as it necessarily is, of sulfanilamide and sulfathiozole as powder dressings, and of sulfapyridine and sulfathiozole internally, have been most effective.

In this connection, I should like to call to your attention that it is the belief of Doctor Alleya that, apparently, the maximum effect of sulfathiozole and sulfapyridine in urinary infections is obtained by comparatively small doses, namely, 2 Gm. per day for an individual weighing 150 pounds.

In conclusion, may I say that, in my opinion, the urogenital injuries sustained during this war will be as frequent and possibly of a more serious nature than those of the last war; and I should like to repeat that the effectiveness of their therapy will be greatly increased by their prompt arrival at a place where they can have the benefit of those specialized diagnostic and therapeutic procedures that can be efficiently maintained only upon, at least, a semipermanent basis.

INJURIES TO THE CHEST*

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THE DANGER from chest wounds is in a large measure due to the narrow margin of safety under which the thoracic viscera work. A rapid change of pressure relationships within the thorax affects the aeration of the blood, the filling and emptying of the heart, and the circulation not only in the thorax but also of the whole body. A knowledge of certain fundamentals of the mechanics of respiration is, therefore, a necessary prerequisite for the surgery of this field. Injuries affecting these relationships may be rapidly fatal and, therefore, worthy of immediate and heroic action.

With the respiratory passages open and the lungs at rest, the pressure within the lungs (the intrapulmonic pressure) is the same as that of the atmosphere; but with inspiration and expiration certain changes take place. With inspiration the pressure becomes slightly less than that of the atmosphere and with expiration the pressure rises slightly. These changes vary greatly with the intensity of the respiratory movements and with the size of the opening to the exterior. Forced expiration with the glottis closed raises the intrapulmonic pressure. A crushing pressure applied to the chest, as may happen in accidents, can raise it to such an extent that one or both lungs may be ruptured, even though the thorax is not penetrated.

The pressure within the thoracic cavity outside the lungs (the intrapleural pressure) is normally negative, due to the elastic recoil force of the lungs. It varies, too, with the depth of respiratory excursions. These changes affect not only the lungs but the whole cardiovascular system, since the intrapleural pressure, including that of the venae cavae as they enter the heart, is normally less than that of the atmosphere. If for any reason there is a change from a negative to a positive pressure, the filling and emptying of the heart is immediately affected.

Conditions are quite different with the thorax opened, and upon a recognition of these conditions are based the fundamental principles of most operative procedures within the thorax. If the opening in the chest is smaller than the larynx, the lung collapses, but on inspiration partial expansion occurs, and respiration in an individual with normal vital capacity is only slightly embarrassed. If the opening is larger than the laryngeal opening, air will enter more freely than through the trachea. The mediastinum will be forced toward the unopened side in inspiration and back toward the opened side in expiration. This condition, known as mediastinal flutter, probably subjects the heart and great vessels to varying degrees of positive and negative pressures.

* Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

In addition, air passes from one lung to the other in useless exchange. All this may lead to rapid asphyxia. Therefore, the first principle in treatment of any sucking wound is immediate closure of the opening, preferably by suture of the skin, or by temporary plugging with the finger, the hand, or by the application of moist gauze.

The main consideration in the treatment of all chest injuries is: (1) The treatment of shock; (2) the arrest of hemorrhage; (3) the replacement of lost blood and fluids; and (4) the restoration of the physiology and dynamics of the cardiorespiratory system.

Thoracic injuries in civil life are different from those seen in war injuries, and are less severe. In the former, a knife, ice-pick, or pistol bullet are the usual weapons; and large sucking wounds, such as are made by shrapnel, are less frequently seen. The lodgment of clothes, ribs and shell fragments, giving rise to serious infection, is, therefore, more rarely a complicating factor.

Pleuropulmonary lesions may be divided into those having (1) open wounds of the thoracic wall; and (2) those having closed wounds. Open wounds are by far the more dangerous, the degree of danger depending upon the size of the wound, the amount of foreign material carried into the chest, and the injury to the viscera. Such wounds should be carefully cleansed, débrided, and sutured as soon as possible.

Pleuropulmonary lesions with a closed wound are more common and far less dangerous. They are usually caused by a knife or ice-pick, and the external wound has closed spontaneously or has been converted into a closed lesion by suture. The main problem in the treatment of thoracic injuries in civil life is, therefore, concerned largely with closed wounds and the conditions arising from injury to the thoracic viscera. Treatment is always dependent on the symptoms exhibited by the individual patient rather than by a set rule. In the main, the treatment is conservative and nonoperative, although operation is carried out for heart wounds, for large lacerated wounds of the lung, for hemorrhage from an intercostal or internal mammary vessel, or for compression pneumothorax.

Simple fracture of one or more ribs requires no special treatment other than immobilization and sedatives. Depressed fractures of ribs or sternum sometimes require elevation of the fragments either under general or local anesthesia. Multiple bilateral rib fractures are more serious because of the complicating factors of shock, hemorrhage and pneumothorax. The patient must be kept comfortable with opiates. Administration of oxygen, by means of the tent or the nasal catheter, often gives relief. Occasionally, in extensive multiple fractures, strapping of the chest makes the patient more uncomfortable, in which case the chest may be wrapped with heavy muslin or elastic stockinette. Nerve block may be tried for relief of pain.

Complications following fractures or any chest injury must be watched for and treated as they arise. The most common are: (a) Pneumothorax; (b) atelectasis; (c) emphysema; (d) hemothorax; (e) contusion and hemor-

rhage into the lung; (f) traumatic asphyxia; (g) paralytic ileus; and (h) empyema.

Traumatic asphyxia is due to violent but temporary compression of the chest. Two types are recognizable. The more common and more serious is characterized by short, uneven respirations. There is a general pallor of the face and neck with areas of purplish discoloration. The pulse is weak but fast, and the skin is cold and clammy. Often the patient is unconscious or stuporous. The treatment is that of shock and the administration of oxygen. If the patient recovers from shock, the prognosis is good. The more rare and less serious type is characterized by ecchymosis of the face, neck, and upper chest. It is caused by compression of the chest, with a sudden rise in the intrapleural pressure, which collapses the veins of the mediastinum, and forcibly ejects the blood into the valveless veins of the neck and head. There are subconjunctival hemorrhages, exophthalmos and hemorrhages into the skin. If uncomplicated, recovery takes place in seven to 20 days. Treatment is supportive with inhalation of oxygen.

Pleuritis is due to contusion of the pleura and may or may not be accompanied by one or more fractured ribs. The patient's chief complaint is pain on inspiration. There is usually a slight rise in temperature, and a friction rub may be heard over the injured area. Occasionally, the pleuritis is accompanied by a clear or bloody effusion. The treatment consists of strapping the chest wall and the administration of sufficient opiates to relieve the pain. Unless the fluid is excessive and respiration is embarrassed, it need not be removed by aspiration.

Injuries of the lung and pleura may produce two types of emphysema: (1) Subcutaneous; and (2) mediastinal. When the lung is torn, and a tension pneumothorax develops, air may be forced through an opening in the parietal pleura into the subcutaneous tissues of the chest wall or even over the greater part of the body. If the lung is injured internally, air may be forced along the peribronchial and perivascular tissues into the mediastinum and from there it may appear in the supraclavicular fossae or in the groin.

The majority of cases of subcutaneous (interstitial) emphysema require no treatment other than that for the chest injury. If the wound in the lung is valvular and the emphysema spreads rapidly, it may be necessary to explore the wound and close the opening in the pleura. Sometimes suturing the intercostal muscles together tightly will suffice, or inserting a needle or trocar into the chest and withdrawing the air. Rarely is it necessary to resort to multiple incisions to relieve the tension.

Emphysema of the mediastinum is rare. If the lung is injured internally, air may be forced along the peribronchial and perivascular tissues to the mediastinum. In cases where the trachea or large bronchi are injured there will probably be extensive mediastinal emphysema, which may greatly embarrass respiration and produce death unless the pressure is relieved. The symptoms are those of crepitation over the suprasternal notch, cardiopulmonary distress, and roentgenographic evidence of air in the mediastinum.

The treatment of mediastinal emphysema depends on the amount of tension present. Some cases can be left alone entirely. Some can be successfully treated by aspirating the air from the pleural cavity, and relieving the tension in the mediastinum. Others have to be treated by incision over the suprasternal notch and allowing the air to escape through the opening. If the latter becomes necessary to prevent collapse of the intramediastinal vessels or trachea, then great care must be taken not to produce infection and mediastinitis.

In thoracic injuries two types of pneumonothorax may be produced: (1) With an open wound of the thoracic wall; and (2) with a closed wound.

If a bilateral pneumothorax is present, the amount of collapse may produce death, due to the marked decrease of the vital capacity of the lungs. This condition demands immediate withdrawal of the air from both by a needle or a catheter.

Tension pneumothorax is a type of valvular pneumothorax, that is, the valvelike tear in the lung allows the air to enter the pleural cavity but prevents its escape. The closed type is seen in cases where the lung is ruptured by external compression when the glottis is closed. The symptoms are shock, cyanosis, dyspnea and shifting of the mediastinum. If the injury in the lung involves the mediastinal pleura, mediastinal emphysema may result, and progress to such an extent that crepitation can be felt in the suprasternal notch.

Tension pneumothorax can be rapidly fatal and should be treated immediately. The best and simplest method is the insertion of a large-gauge needle into the pleural cavity and thus allow the air to escape through the needle, which is connected to a rubber tube, the lower end of the tube being submerged in water two or three feet below the level of the bed.

Uncomplicated pneumothorax without tension requires no treatment other than keeping the patient semiupright in bed for a few days, because air is rapidly absorbed by the pleura.

Large open pneumothorax may result in death quickly, due to mediastinal flutter. The mediastinal flutter can be prevented during closure of the wound by steadying the lung with forceps.

Blood may collect in one or both pleural cavities following any thoracic injury. Most penetrating wounds of the chest are followed by the accumulation of some blood in the pleural cavity, varying from an imperceptible amount to several liters. There are several sources from which the blood may come, the most frequent being from the injured lung. It may also come from severed intercostal vessels, internal mammary vessels, the azygos veins, the heart, or even from injured abdominal viscera if the diaphragm has been penetrated. The amount of collapse of the lung and, therefore, the amount of dyspnea depends upon the amount of blood and air in the pleural cavities. Many cases of hemothorax are accompanied by varying degrees of pneumothorax.

The treatment of hemothorax depends upon the amount of hemorrhage and its source. If the bleeding is from an intercostal or internal mammary

vessel, the vessel should be ligated immediately. If the hemorrhage is from the lung, bleeding will usually continue until the intrapleural pressure rises high enough to serve as a tamponade, which stops the bleeding.

If the amount of hemorrhage is not great enough to produce distressing respiratory symptoms and is not steadily increasing in amount, then it should be left alone. In such cases the patient should be placed in a semiupright position to facilitate respiration, and given sufficient morphine for rest. Morphine not only makes the patient more comfortable but is valuable in controlling further hemorrhage by decreasing physical and respiratory movements, thus allowing quicker clotting at the point of hemorrhage.

Whenever possible, the blood should be left in the chest. If the blood is withdrawn, the lung will reexpand and hemorrhage start anew. Instead of decreasing the chances of empyema developing, aspiration will increase the chances because it is an added avenue of entrance for bacteria. In over 95 per cent of the cases the blood is readily absorbed. The only indications for aspiration are severe dyspnea and pain.

If hemorrhage is sufficient to cause distressing respiratory difficulty, then thoracentesis must be performed and enough blood withdrawn to bring about comfort. It is best to replace the blood withdrawn with the same amount of air to maintain sufficient intrapleural pressure to prevent further hemorrhage from the injured lung. If hemorrhage persists in filling the chest, it may be necessary to cauterize the bleeding point through a thoracoscope, or the chest may have to be opened and the hemorrhage controlled with ligatures or packs. Several transfusions may be necessary.

Atelectasis may involve an entire lung, one lobe or a few lobules. Massive collapse results if a large bronchus becomes plugged. Following thoracic trauma, the atelectasis *per sc* needs no treatment. When atelectasis is due to plugging of a bronchus, an attempt should be made to remove the plug by turning the patient from side to side, by giving expectorants, or with the aid of a bronchoscope.

Prolapse of the lung may occur in open, sucking wounds of the chest. If the lung is expelled through the wound as a result of a cough or severe strain, it may be caught by a fragment of a fractured rib. The lung tissue may be seen protruding through or into the wound. It is accompanied by pneumothorax, mediastinal flutter, and possibly some degree of hemothorax but usually in slight degree.

Treatment consists of holding the lung in the prolapsed position with sponge forceps, under hyperpressure anesthesia, while débridement of the wound is carried out and the lung is then cleaned and sutured. The external wound is closed tight. If drainage is necessary, it should be of the water-seal type.

Chylothorax results from damage to the thoracic duct as it passes though the mediastinum. It occurs infrequently and may easily be mistaken at first for empyema, as the fluid is gray and saguineous. It appears one to three days following a chest injury and soon produces respiratory distress which rapidly

requires aspiration. If the aspirated fluid is allowed to stand, it will separate into an upper milky and a lower bloody layer. Analysis of the fluid reveals fat to be present.

Treatment is chiefly that of repeated aspirations. The frequency of aspiration depends on the amount and occurrence of respiratory embarrassment.

Crushing injuries of the chest are frequently seen as a result of automobile accidents. Many are immediately fatal and are due to rupture of the heart, lungs or great vessels as a result of compression, or penetration of the viscera by sternum or broken ribs. Little attention has been paid to nonpenetrating heart lesions which are not fatal. Certainly, there is no reason to believe that the heart, situated as it is between the sternum and the spine, is not subject to contusions of considerable severity and from which recovery takes place in the majority of instances. The most common cause of such an injury is one in which the driver is suddenly thrown forward against the steering wheel, and the sudden compression may injure the heart without fracturing the sternum or ribs. Any patient who is struck in the chest should be suspected of such an injury, particularly if symptoms of precordial pain, dyspnea and tachycardia are present. Persistence of these symptoms, together with irregularity of the heart, cyanosis and a peculiar "tick-tick" quality of heart sounds, makes the diagnosis almost certain. The treatment is entirely symptomatic. The chief reliance is to be placed on morphine and sedatives for rest, and on oxygen for dyspnea and cyanosis. The patient should be confined to bed until all symptoms have subsided.

Penetrating wounds of the heart are usually produced by a stab or bullet. Occasionally freak accidents may result in penetration of the heart. Approximately 2 per cent of penetrating wounds of the chest injure the heart. If patients who die of cardiac wounds but never reach the hospital were considered, the percentage would probably be higher.

Symptoms of exhaustion, collapse, cessation of bleeding from the external wound, and frequently unconsciousness are due to tamponade and loss of blood. When the heart is wounded, it usually bleeds freely into the pleural cavity or to the outside. At the same time blood collects in the pericardial sac. When from 100 to 200 cc. has collected, the pericardium becomes distended, the intrapericardial pressure rises, and the venae cavae can no longer empty normal quantities of blood into the heart. The heart being unable to fill to capacity, can no longer empty, and cerebral anemia results.

To aid in the diagnosis the venous pressure should be taken and the heart viewed through the fluoroscope. Under the fluoroscope, the normally active cardiac shadow is seen to be motionless, or its amplitude greatly reduced. The normal venous pressure is 75 to 125 Mm. of water, but in cases of tamponade the venous pressure may rise as high as 340 Mm. of water and still be compatible with life, if the pressure is not maintained for too long a period.

In summary, a lowered or falling arterial pressure, a high or rising venous pressure, and the absence of cardiac pulsations by fluoroscopic examination make the diagnosis of tamponade practically certain.

The treatment is immediate operation. In order to save time, instruments needed for the operation should be kept ready at all times in a separate container. When the operation is begun, fluids should be started intravenously, but should be given slowly until the pericardium is opened and the tamponade is relieved. Transfusions of whole blood should be given to replace the lost blood. Autotransfusions are often life-saving. Several types of incisions have been advocated for approaching the heart, but the main aim is to secure its rapid exposure. The intercostochondral thoracotomy (Spangaro), with removal of one or more cartilages and a portion of the sternum, is probably the easiest and speediest. With any type of incision the internal mammary vessels are ligated and the lung and pleura are displaced outward by gauze dissection. Injury to the pleura should be avoided if possible. The pericardium should be opened, and the blood and clots aspirated. The wound in the heart can often be covered with a finger until a suture can be placed. It may require several sutures to close the perforation. After all blood and clots have been removed from the pericardium, it should be closed loosely in order to provide drainage of serum and residual blood into the pleural cavity. If the pleura has been damaged, an attempt should be made to repair it and the wound closed in layers. Silk is used throughout. Wounds of the right ventricle offer the best prognosis.

Perforation of the diaphragm, with or without abdominal injury, may result from various types of thoracic injuries and are probably more common than is realized. Unless there is an accompanying abdominal injury, many cases may go for weeks or even months before being recognized. Probably, many cases are never recognized if the perforation is small or incomplete.

There are no distinctive early symptoms unless there has been some abdominal damage. Later the symptoms of diaphragmatic hernia develop. Treatment is symptomatic. The chest injury must be treated, according to what damage has been done. If signs and symptoms of perforation of an abdominal viscus are found, an exploratory celiotomy must be performed and the damage repaired. Bullet wounds and wounds from long knives are the most common causes of thoraco-abdominal injuries.

SUMMARY

(I) The treatment of chest wounds is in the main conservative, directed toward: (1) The treatment of shock; (2) the arrest of hemorrhage and the replacement of lost blood; and (3) the restoration of the normal physiology and dynamics of the cardiorespiratory system.

(II) Active and immediate operative procedures are indicated in sucking wounds of the chest, persistent hemorrhage, tension pneumothorax and penetrating wounds of the heart.

DISCUSSION.—DR. A. O. SINGLETON (Galveston, Tex.): I shall direct my remarks to only one type of injury, and that is penetrating wounds of the heart. These wounds may be either gunshot or stab wounds. One of my associates, a young man who sees the humorous side of things very readily,

says he can prognosticate the times by the wounds the Negroes have in our part of the country. In prosperous times they buy bullets—and gunshot wounds prevail, and in "hard times" they use a knife. At the present time we are not seeing so many stab wounds.

With stab wounds of the heart, the patient dies of one of two causes. He may die immediately, of course, but if he lives longer he will die of heart compression or from hemorrhage. The hemorrhage will be into the pleural cavity, the wound having penetrated the pleura and pericardium. Those who die of compression have a wound which did not penetrate the pleura. By the physical signs one can usually tell whether the patient had a thoracic wound of the heart or an extrathoracic one. Aspiration of the pleura and, if necessary, of the pericardium may be advisable. Where the pleura has not been soiled, it is important to avoid opening it when operating. Where the wound has penetrated the pericardium and the pleura, it is important to approach the heart through the pleura. By studying these cases I think one is able to determine fairly accurately when operative approach for suture of the heart is indicated.

DR. DERYL HART (Durham, N. C.): In our experience, we have had little trouble with hemorrhage into the pleural cavity when the patient comes in shortly after the injury. Our most difficult problems have been in handling those patients who come in several weeks after receiving a puncture wound of the chest. The blood has not been evacuated, and the temperature is moderately elevated. Aspiration reveals an infection of a relatively low grade and subsequent roentgenograms show a multiloculated cavity, apparently formed by partial organization of the blood clot, occupying the pleural space left by the collapse of the lung. The problem of getting the lung to reexpand is far more difficult than in the usual empyema of a similar duration. It has seemed to me that in the presence of a large hemorrhage which has not been evacuated, the fibrosis and tying down of the lung is more rapid than in the presence of an acute empyema of like duration.

I wondered if Doctor Elkin has found that not evacuating a large hemorrhage predisposes to subsequent limitation of motion on that side of the chest, and also what experience he may have had with handling low-grade infections in partially organized hematomata of several weeks' duration.

DR. I. A. BIGGER (Richmond, Va.): I enjoyed Doctor Elkin's paper and agree with most of the things he has said. However, there is some question in my mind in regard to his method of handling hemothorax. It has seemed to us that when there is a large amount of blood in the pleural cavity, even though there are no pressure symptoms, it is wise to evacuate it because of the value of the blood itself. If the patient is seen early and there is no evidence of gross contamination, you have an excellent supply of blood for autotransfusion. If the blood is aspirated within a few hours, I know of no reason why it should not be returned to the patient's circulation. Recently, Dr. H. J. Warthen, Jr., operated upon a patient for a heart wound which communicated with the left pleural cavity. Thirteen hundred cubic centimeters of blood were aspirated from the pleural cavity, citrated, filtered, and used for autotransfusion. We believe that this may have influenced the outcome. It does seem that if there is uncontaminated blood in the pleural cavity it should be aspirated and replaced by air. Simultaneous air replacement prevents the danger of reactivating the hemorrhage by changing the intrathoracic pressure.

One other point on which Doctor Elkin and I have previously disagreed is the question of aspiration in certain patients with acute cardiac tamponade,

a procedure which I believe Doctor Singleton first recommended. When patients with tamponade show a temporary response to conservative measures, relief of pressure by aspiration may prove to be the only treatment necessary. The very serious ones, who show less response to conservative measures, may be tided over by aspiration while adequate preparations are made for operation. In military practice aspiration should be of great value, for a large percentage of patients with heart wounds will die of tamponade before they can be transported to stations with adequate facilities for thoracotomy and cardiorrhaphy.

DR. DANIEL C. ELKIN (Atlanta, Ga., closing): In answer to Doctor Hart's question, there are certainly some cases in which, if blood is left in the chest, fibrosis and low-grade infection develop. These are difficult to cure. In some 1,500 cases of wounds of the chest we have had only 3 per cent infections—treated for the most part by conservative measures. I believe if all cases were aspirated or opened and cleansed of clots and fibrin and blood, infection would be high, and I think it is the lesser of two evils to treat them by aspiration unless symptoms of pain are present. If definite infection is present it must be treated as empyema. The question of aspirating to relieve compression of the heart by blood is an extremely difficult one to decide. Undoubtedly, there are some cases with definite tamponade of the heart, which if left alone will recover. Certainly, they could be cured by aspiration—but, how to choose these cases? Therefore, I think if these signs are present it is safer, in the long run, to operate and suture the heart.

THE RÔLE OF THE PLASTIC SURGEON IN THE CARE OF WAR INJURIES*

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FOR OUR PARTICIPATION in the World War, General Gorgas made definite provision to give special care to face and mouth wounds from the time of injury until final total restoration, as far as the latter was surgically and physically possible. This preparation embraced personnel and consultants, special equipment, and even dictated definite plans of procedure in cases where either the preservation of life or the possibility of ultimate rehabilitation might depend upon the kind of early treatment given, but all correlated to general plans of hospitalization, evacuation and transportation. Fortunately, the opportunity to use the plan was of short duration, but that the scheme was basically sound was proved by the fact that the majority of face and mouth injuries returning to this country as casualties had been wounded previous to St. Mihiel, before the plan could be put in anything like general operation. Though a much larger number of such injuries were sustained at St. Mihiel, the Argonne, and later, it is to be inferred from the records of the surgeon general, that the majority of the latter had been returned to duty before the time of embarcation.

In this country the care of these cases was rather indiscriminately referred to as "Plastic Surgery" or "the care of face and mouth wounds," but in the A.E.F. it was definitely classed as "Faciomaxillary Surgery," and it was because of their high percentage of occurrence in trench warfare that a special division was organized for their treatment. Many were almost immediately fatal, and most of those surviving who had not been given a correct start from the first were ambulatory for long periods, becoming indolent, resentful of discipline, and lacking in morale, while the government's policy of paying these men to remain idle proved far from helpful. In the aggregate, these became an immense expense to the government, and a small but vociferous minority were a "headache" to those assigned to their care. All of the above had been foreshadowed in the experiences of our Allies, but with us the difficulties were exaggerated both by the individualism of the American soldier and by well-meant but overenthusiastic expressions of civilian sympathy.

No special activity can survive in an army that is not smoothly geared to normal running of the whole scheme, which in action rates in importance first: men; then ammunition and food; the activities of the medical department coming fourth; therefore, it behooved that our division carry on inconspicuously.

To be welcome as well as useful in Front areas, Field and Mobile hospitals, it is more important that men designated for any special work be all 'round well-trained general surgeons than that they have any highly specialized know-

* Read before the Fifty-third Annual Session of the Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

ledge of plastic surgery or any other special type of surgery. In a "putsch" in those days, operating surgeons in such hospitals were expected to work for 12-hour periods and to take on everything brought to their tables from fractured skulls to fractured toes, including all types of injuries anywhere in between. If they could not do this, they might prove more of a hindrance than a help.

The average dental surgeon has special knowledge of the treatment of jaw fractures. The well-trained surgeon is skilled in the care of the tissues of the whole body; by pairing these—a dentist and a doctor—into individual working units, we were eventually able to put the care of face and mouth injuries on a par with other standardized procedures. All we asked of those designated to care for face injuries in advanced areas was that they be familiar with a few simple working rules aimed at the preservation of life and tissue, that they call for and work with the dental surgeon on all jaw or face fractures whether open or simple, that each carry the needed simple special equipment in his *musette,* and, above all, that they never forget that they are under the orders of the commanding officer of the hospital wherever they might be even temporarily stationed.

The late care of these cases can best be undertaken in selected wards or hospitals where special skill and equipment are available, but these must be situated in the lines of evacuation. To reverse the stream of the latter, can be about as easy as reversing the flow of the Mississippi River. One of the pet schemes conceived in the office of the surgeon general, and sanctioned by the chief surgeon and by the chief dental surgeon of the A.E.F., was a hospital to be used for head and face injuries. This was finally located in one of the largest and newest hotels in Vichy, especially staffed and equipped, but, unfortunately, off the line of evacuation to the port of embarcation, with the result aptly pictured in the lament of the chief ophthalmologic surgeon who, ineffectually, objected to having his ward filled with leg and arm cases, protesting that, "except socially," he "had not seen a leg in 20 years."

Unless "digging-in" again becomes prevalent, faciomaxillary surgery will likely never again attain to the spotlight prominence it had acquired long before we got our cue of entry; however, the niceties of treatment which largely determine both the quality of the final result, and whether the recovery period will be measured by days, months, or possibly years, are still just as important to the individual casualty as if he were a battalion.

The above is a high-spot review of the impressions gained in seven months of preparation in the surgeon general's office, ten months of active duty in France previous to the Armistice, and 20 years of postwar caring for the injured—but all this would be meaningless did it not carry some possibly practical suggestions applicable to the future.

The type of surgery at present commonly designated as "plastic," is one of the oldest of the surgical arts, and has only an accidental relation to dentistry, or to any other surgical field. The machine age, more than war, has again emphasized and enlarged the need for this older type of surgery, and the call is being answered by men having, on the average, a little different

mental make-up than those who prefer to work in problems related to the special sense or the vital organs. Many of the same type of surgeons as those who responded to the call for Faciomaxillary Units have, in civilian practice, developed special skill for working in every part of the body, and in war surgery these could be just as economically and humanely valuable as in civil practice. There is a narrow or wide "no-man's-land" bordering



A B

FIG. 1.—A female, age 29, had been deeply burned about chest, arms and neck by an explosion of stove polish, two and one-half months previously. In the meantime, she had been dressed with white vaseline and 2 per cent mercurochrome. (A) Shows patient's condition of absolute terror when she arrived at the hospital, and at that time she weighed 83 lbs. Her first six dressings were done under gas anesthesia, and later, piece-meal inch-square grafts were applied to the uncut granulations at intervals. Each piece of graft was held firm by a suture anchored in the deep scar and tied over an individual small wad of gauze. All together, at different admissions, she was in and out of the hospital for a period of 15 months, and that she recovered is a tribute to the skill, kindness and perseverance of Dr. Kenneth Lewis, who at that time was a dresser on our service. (B) A photograph of the patient sent to us some time later.

most all special fields in surgery which is apt to be shunned by the men working on either side. It is in these "no-man's areas" of the body surface that the basically trained plastic surgeon can make himself really useful. As one example, let me cite the late care of large third degree burns, which were quite common both in field and naval engagements. After a few weeks, such a patient is no longer suffering from a burn but from a usually infected surface wound, which if left to the natural repair devices may be months in healing, or complete closure may never occur; in the meantime both vital and motor function being imperiled by both infection and excessive scar, while physical and mental suffering (Fig. 1), and the economic drain may be of any extent (Fig. 2). Yet by proper restorative surgery most all of this can be avoided and the recovery period reduced from years to weeks.

It is interesting to look back to the discussions, the literature, and the treatment we observed of major burn cases in the World War; almost the whole problem seemed to be to evolve a dressing that would protect and encourage the slow process of healing by the ingrowth of epithelium upon

the granulation, but never the early elimination of the wound and symptoms by massive skin grafting. The skilled plastic surgeon should be able to sharpen an old-fashioned razor and cut 100 square inches of split-skin graft in a relatively short time, and he should, on the average, be best suited to

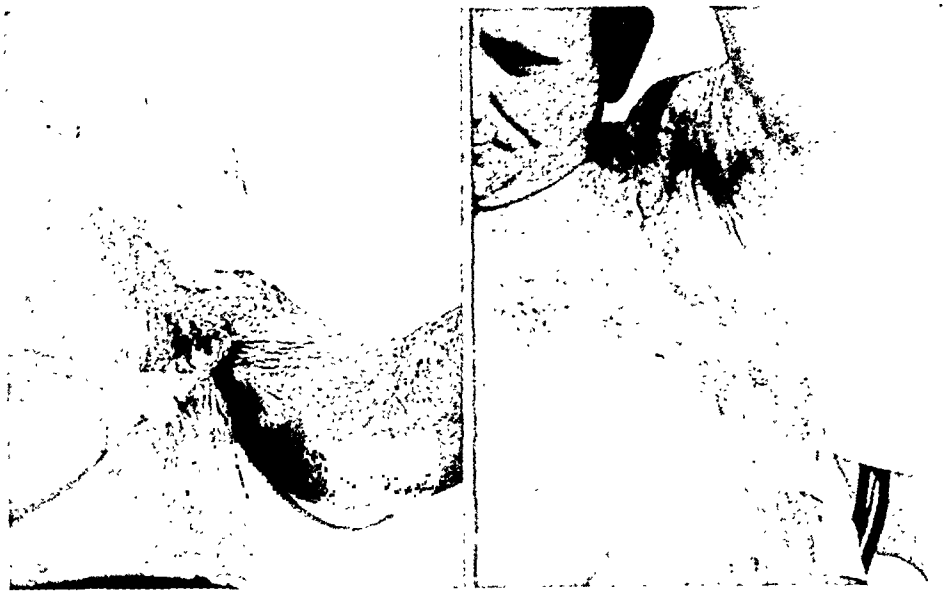


A B

FIG. 2.—A man, age 27, had been deeply burned on the backs and sides of both thighs and legs, 18 months previously. (A) Shows the condition at the time of our first examination: There being a partial backward subluxation of both tibiae, with a flexion deformity of 30°. Owing to the joint deformity and an intercurrent acute appendix, it was 60 days before the left limb was grafted, and the right was done 30 days later. (B) Shows the condition 15 days after the right side was grafted. A year later the scar on the right limb broke down above the original graft and required further grafting. From the economic standpoint, this case was of special interest, he and the family having reported that they spent more than $1,200 for a widely advertised burn ointment in addition to dressings during the 18 months before the grafts were applied.

do the work. In the proposal that the *late* care of extensive burns be turned over to plastic surgical units, I am not suggesting infringement on the field of the general or any other surgeon, but it is just a suggestion to prevent these large deep burn cases from becoming surgical "junk," which too often happens. In this regard, conditions in civil practice appear to be nothing to boast of. During the 20 years following the armistice, Dr. James Barrett Brown, Dr. Louis T. Byars, and the writer treated 340 late burn injuries that had remained unhealed or continued to be an inconvenience or crippling for periods varying from three months to an ordinary lifetime after occurrence of the injury (Fig. 3). The average time that had elapsed between injury and inauguration of surgical repair was 5.1 years. The aggregate period of disability in this group from the time of injury until final discharge was

2,312 years, or an average of 6.8 years for each case. These required 1,037 repair operations, with an average treatment and observation period of 1.7 years per case (Figs. 4 and 5). From our experience in the earlier care of deep burns of similar extent, it seems fair to assume that with more con-



A B

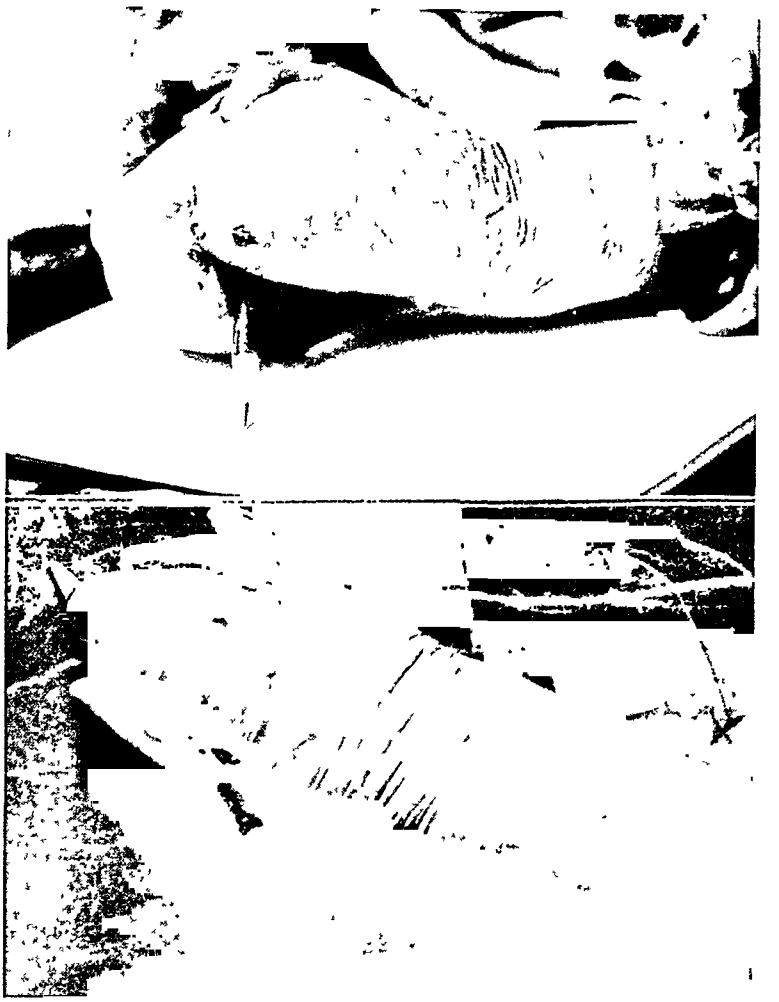
FIG. 3.—A male, age 31, had been burned at age 16, by a live wire. For the past two weeks he had had an open ulcer in the scar at the elbow. He had received $40,000–$50,000 in compensation, but when he came to us he was on relief. The ulcer proved to be a carcinoma developing in the scar. (A) Shows the condition at our first examination. (B) Shows the condition seven months after a wide excision of the ulcer, the arm having been freed in such a way that its raw surface could be almost completely covered from the chest flaps that remained attached to it. The raw surface was covered with split-skin grafts as shown. He ultimately died from recurrence of the carcinoma.

structive treatment the great majority of the above 340 cases could have been successfully restored to approximately normal function and acceptable appearance within three months from the time of injury, with half the number of repair operations and very much better average results than was possible with these late-treated cases (Figs. 6 and 7). Reducing the average disability period for each of the above late-treated cases from 6.8 years to the estimated average of three months per properly early-treated case would reduce the total disability period of the whole group from 2,312 years to 82 years.

DISCUSSION.—DR. ROBERT H. IVY (Philadelphia, Pa.): It is a great privilege to be invited here to discuss Doctor Blair's paper. I had the honor of assisting him in the preparation of the plans for care of these injuries during the late war, and that experience has been of great help to me in my own work and in helping formulate plans for what may happen in the future.

I believe the theory of keeping in mind the broader aspect of this field is sound; that is, that it embraces plastic repair of injuries all over the body and that it is not limited to face injuries. This comprehensive view has not been lost sight of in the surgeon-general's office and the special committees formed by the National Research Council. There are, however,

A



B

FIG. 4.—A female, age 23, had been in a gasoline explosion, two years previously, and, among other injuries, seemed to have lost all of the skin of both hands except in the cleft between the left thumb and index finger and also some extensor tendons. Six months later the right thumb and one *finger on the left hand had been freed by simple incision, without grafting,* but, naturally, the new clefts became obliterated in the healing. (A) Shows the condition when patient came to us—with only the left thumb free; and it, also, shows how she was able to write. (B) Shows the condition of the right hand two months later—the three clefts having been established with full thickness skin grafts Also, the lost soft tissues of the back of the left hand and fingers had been replaced by a pocket graft from the left thigh, preliminary to restoring the three inner clefts She did not return for completion of the work. A letter received six months later states: "My hands are doing nicely. I can do almost everything I wish"



FIG. 5.—A female, age 38, had had a mangle burn, eight months previously, which, evidently, was not much deeper than the skin, as the extensor tendons appeared to be intact. This was allowed to heal naturally. (A) Shows the condition at the time of our first examination. The metacarpophalangeal joints seemed to be intact, but the interphalangeal joins of the second, third and fourth fingers were fixed. The scar was dissected from the back of the hand and four inner fingers, and the hand and fingers placed in a glove-shaped subcutaneous pocket in the upper part of the left thigh, and later removed; the clefts established; and the borders of the flaps sutured to the hand and fingers; and the fingers dressed in a semiflexed position over the end of a padded splint. A month after the flap was sutured in place, the spring traction splint shown in (B) was put in use, but it failed to reestablish movement at the proximal interphalangeal joints of the index and middle fingers. Later, the distal ends of the proximal phalanges were removed to establish false joints. (C) and (D) Show the appearance and amount of movement ultimately gained six years after our first treatment. It is most likely that a skin graft applied three or four weeks after the burn was received, would have forestalled the periarticular fixation, and the glove-pocket flap applied soon after healing would have given a quick recovery with no joint fixation.

certain special features to be remembered in connection with face injuries, and the general surgeon should realize that cooperation with the dental surgeon is of utmost importance. The ideas started by Doctor Blair during the last war will be fully utilized in plans which are being formulated for the treatment of these injuries in future wars.



FIG. 6.



FIG. 7A.



FIG. 7B.

FIG. 6.—A male, age 60, was burned by being pinned under an overturned tractor for one hour and 45 minutes, with the muffler in contact with his left flank and back. It was found that the burn extended to the muscles and crest of the ilium. The area was partially débrided and wet dressings applied. Five weeks later the whole area, which was more than a square foot in extent, was covered with split-skin grafts, excepting a protruding burned part of the crest of the ilium. The photograph was taken two months after the injury, and three weeks after he grafts were applied. At this time, the patient went back to his job as a farm superintendent, still wearing a dressing over the protruding burned bone.

FIG. 7.—A male, age 42, had been burned by his clothing catching fire, 32 years previously. He was burned from knee to shoulder on the right side. Over the right buttock and thigh there was a large area of hard scar, which had broken down repeatedly. At the time of our examination there was an ulcer, 4x5 inches, that had been open for two and one-half years as shown in (A). This raw area was dissected out widely, including much thick surrounding scar, leaving a defect twice as large as the ulcer. This was covered with split-skin grafts which took completely. (B) A photograph, 42 days later, shows the extent of the graft A letter, received one year later, reported a perfectly satisfactory result. The microscopic examination of the tissue removed from the ulcer border showed chronic inflammation.

The principal points in face and jaw injuries to be stressed at advanced posts, where there are no specialists or where the assignments are general are, first of all, arrest of hemorrhage. The second point is the establishment of proper airway, by holding the tongue forward with a suture, or passing a rubber tube back to the throat through the nose, or by placing an appliance to hold the collapsed jaw bones forward. The third thing is temporary fixation of the jaw fracture by emergency appliances before any attempt is made at closing the wound. Doctor Blair spoke about not closing the soft tissues over a fracture. It is important to reduce and fix the bone fragments and later close the soft tissues. The fourth thing is provision for safe transportation. These faciomaxillary cases should be sitting up if possible. If they have to be recumbent on a litter, they should be on the face, not on the back, and in that way many lives will be saved.

NEW DEVELOPMENTS IN THE TREATMENT OF COMPOUND FRACTURES*

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THE POSSIBILITY of participation in hostilities, as well as the ever-increasing number of traffic and industrial accidents, has stimulated renewed interest in the treatment of compound fractures. Basic principles of treatment remain unaltered, but various modifications of details have been suggested with increasing frequency during the last two or three years. Some of these variations in treatment are fundamentally sound, whereas many others, based on unreliable statistics, are misleading.

The failure of analyzers of series of cases, when reporting upon methods of wound treatment, to differentiate between soil-contaminated compound fractures, with much tissue damage, and those fractures produced by indirect violence, with only a small puncture wound, has only added to our confusion of the subject. Approximately 300 compound fracture cases were seen at Charity Hospital in New Orleans during 1939–1940. I recently reviewed these in regard to treatment for prevention of gas gangrene. Of these 300, only 187 had fractures of the long bones, and after eliminating those that died of other causes within 24 hours, those received late, and those with small punctured wounds, there remained only 20 cases of truly soil-contaminated, recent compound fractures suitable for analysis with reference to treatment. Conclusions concerning the occurrence of gas gangrene based upon all of the compound fractures, or even all cases involving the long bones, would have been most inaccurate. The statistics offered as evidence of the value of roentgenotherapy and chemotherapy in treating the complication of gas gangrene, without indicating whether or not surgical measures were employed concomitantly with these procedures, have left us in doubt as to their value.

The fundamental importance of adequate splinting of compound fractures where the injury occurs remains unchallenged. Opinions vary, however, as to the advisability of drawing a dirty, projecting fragment of bone back into the tissues when applying a fixed traction splint for transportation. Since it is universally agreed that all of these fractures must be débrided when they arrive at an hospital, and that traction splints, properly applied, provide maximum fixation and protection in transit, there can be no valid reason for failure to employ them when they are available.

The patient's general condition continues to be our first consideration in the management of compound fractures. Because of the investigations of

* Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

John Scudder,[1] and others, it is now possible, by simple measures, to estimate dehydration accurately and promptly, and to determine whether or not the administered fluids are being utilized sufficiently. In addition to these valuable contributions to the control of shock, the development of blood banks and, more recently, of pooled plasma, make it feasible to relieve severely shocked patients promptly. So great is the possibility of rallying these patients, whose shock is the direct result of compound fractures of the extremities, that Murray[2] recently stated: "If shock treatment is adequate, infusion, transfusion, cortin, *etc.*—there is no reason why the patient cannot go to the operating room, where his débridement is performed, while shock treatment is being carried out." Many will not be as sure as Murray of the efficacy of their measures to control shock, but no one will deny that every hour that can be gained in performing early débridements will diminish the incidence of serious infections and, coupled with other measures of chemotherapy now available, make more possible the use of internal fixation and the closure of wounds in selected cases.

Administration of combined antitoxins for tetanus and gas gangrene has become almost a routine procedure in the emergency rooms of all hospitals receiving compound fractures. Recent developments in the use of tetanus toxoid[3] indicate that it is practical and efficacious in preventing tetanus. It is probable that all army recruits will be thus immunized, and that in the future children will receive tetanus and diphtheria toxoid together. The efficacy of gas gangrene antitoxin as a prophylactic measure has never been generally accepted. With earlier and more efficient débridement, and the possibilities of chemotherapy in preventing wound infections, gas gangrene antitoxin may eventually be omitted as a routine preventive measure. In civil practice, however, the combined sera will doubtless be continued for some years.

The best manner of preparing the skin and the wound for operation has been a controversial question for years. Most American surgeons[4, 5, 6, 7] favor shaving and washing the skin with soap and water, and subsequently irrigating the wound abundantly with saline and sterile water. Boehler,[8] and Watson-Jones[9] emphasize, on the contrary, the importance of avoiding extensive skin preparation and the use of irrigating solutions during and following operation. They rely rather upon cleansing the immediate wound area with ether or painting it with iodine, and removing all foreign material from the wound by meticulous dissection through a wide exposure, under good light. Under military conditions the latter method will probably be the accepted one, and should, therefore, be adopted in training centers.

Too little attention has generally been given to maintaining immobilization of the fracture during the period of skin preparation, draping and operation. Among others, Winnett Orr,[10] and Watson-Jones[9] emphasize the importance of transferring the fractured extremity from the transportation splint directly to the traction devices of a fracture table before preparation of the skin and operation are undertaken. When transfixion of the fragments above and below with Steinmann pins is the desirable method for postoperative fixation,

the whole procedure can be simplified by first inserting the pins, attaching the limb to a traction device, and then proceeding with the skin preparation and operation.

Whereas the use of strong antiseptics in the wound is generally condemned and even irrigation with bland solutions is considered undesirable, there is an increasing tendency to implant crystals of sulfanilamide into the débrided wound rather than to depend upon administration of the drug orally or parenterally following operation. Key[11] has reported experimental and clinical observations indicating that the drug does not injure tissues nor joint structures, and does not interfere with healing or union. Jensen, *et al.*[12] were able to lower the incidence of infection in compound wounds treated by early débridement and implantation of sulfanilamide crystals in the wound. Bohlman,[13] and Johnson[14] believe that this compound prevents and controls gas gangrene infections. Watson-Jones,[15] in a personal communication of July, 1940, stated: "Prophylactic chemotherapy has been employed in compound and gunshot fractures for a considerable time, but I believe that it is still too soon to judge the relative merits of sulfanilamide melted into the wound, and the same preparation given by mouth or injection, and also too soon to know how much better prophylactic chemotherapy may be than chemotherapy instituted at the first sign of infection."

I[16] performed some experiments on guinea-pigs, injecting lethal doses of *C. welchii* in thigh wounds, débrided them early, implanted sulfanilamide crystals, and closed the wounds. Most of these animals died with gas gangrene; whereas, in another series, in which the wounds were débrided early and left open, and sulfanilamide was injected intraperitoneally, most of the animals survived and few had gas gangrene.

Implantation of Sulfanilamide Crystals

Nineteen guinea-pigs, routine preparation; from one to six hours after inoculation—débridement; implantation of 15–30 mg. sulfanilamide crystals; suture. Eight controls.

Results:	Died, 6–48 hours	15
	Lived	4
	Controls died, 14–86 hours	8

Gas Gangrene Experiments

Wounds of nine guinea-pigs débrided at two hours and left open. Sulfanilamide by intraperitoneal injection.

Results:	Lived	7
	Died	2
Two Controls, débrided and left open:		
	Lived	1
	Died	1

These experiments suggest that we should be wary of closing the wounds after débridement in cases with extensive tissue damage and soil contamination, even when sulfanilamide can be melted into them or administered by mouth.

Fragmentary reports from surgeons[17, 18] who worked in Spain, and in

Finland during recent wars, indicate that they were unable to close the wounds in many cases even when sulfanilamide could be given. They also report a very low incidence of gas gangrene. Whereas sulfanilamide is a valuable adjunct to débridement in the prevention of serious wound infections, it is, at best, only a bacteriostatic agent (not bactericidal) which is less effective against the anaerobes than against other organisms. Therefore, wounds laden with organisms from fertilized soil should be sutured with great hesitancy.

Extensive lacerations over subcutaneous bones, such as the tibia, may be sutured provided counterincisions of adequate length are made elsewhere through the skin and deep fascia, extending down to the site of fracture. Wounds of the joints may be débrided, lavaged and sutured as a rule, even in the presence of gross dirt, because the joint structures provide a poor culture medium for the propagation of gas bacilli.

Internal fixation of the fracture following débridement can be, and has been, safely performed in those patients whose general condition is good if they are seen within a few hours, after incurrence of a compound fracture of the leg or arm, by a competent surgeon and good assistants who have a complete armamentarium of instruments, plates and screws of Vitallium, together with sulfanilamide. Although this is the ideal method of securing that perfect immobilization essential to prevention of the development of infection, the conditions described are seldom encountered, especially on or near a battlefield. Recourse must, therefore, be taken to those appliances which permit the maintenance of alignment and approximation of fragments at the same time that the wound is being dressed.

Encasement of the limb in closed plaster, with the wound open, does not prevent the escape of odors that are discouraging to both patient and physician. Frequent dressing of the wound with strong chemicals, or copious irrigations through small windows in the plaster, undoubtedly retard healing. However, in most cases, it is possible, by exercising some ingenuity, to maintain adequate fixation and alignment while retaining sufficient exposure of the wound to change dressings, cleanse the skin margins, and carefully apply bland ointments. When this is done the wound heals rapidly, the patient is more comfortable, and the atmosphere of the hospital ceases to be reminiscent of the days before Lister and Pasteur. The recent advent of pectin and its combination with sulfathiazole, suggested by Thomson,[19] makes possible a thin jellylike ointment which, in our hands, has eliminated the odors from nearly all pyogenic wounds communicating with bone, has rapidly diminished the quantity of purulent discharge, and has produced healthy granulations and earlier healing than we have observed with any other type of dressing.

The most dreaded complication of soil-contaminated compound fractures is gas gangrene. Anaerobic culture of all the excised tissue removed when the wound is débrided, as recommended by Meleney,[18] determines the presence of *C. welchii*, thus enabling the surgeon to be alert to the development of early symptoms. If excessive pain and swelling occur within 24 to 36

hours, the wound should be dressed and the surgeon should look for the typical brick-red, watery discharge, with the unmistakable pungent odor that is so characteristic in gas gangrene. These signs are usually easily observed before there is roentgenologic evidence of gas in the muscle layers. At this stage, administration of large doses of gas gangrene antitoxin and sulfanilamide by mouth until the blood level is high, extensive incisions of skin and fascia, with excision of the entire length of involved muscles, and the application of zinc peroxide paste to the open wound, probably offer the best means of arresting progress of the disease. If the wound is below the knee or elbow, these measures instituted early will usually suffice, but if there is extensive involvement in the midthigh or upper arm, the prognosis, at best, is poor. If further progress of the disease is noted within 12 to 24 hours after operation, disarticulation at the knee or elbow is the only safe procedure.

The claims of some radiologists[21] and surgeons that roentgenotherapy is a valuable prophylactic measure, that roentgenograms reveal the earliest evidence of the infection, and that further roentgenotherapy will arrest progress of the infection, especially when chemotherapy and surgical measures are carefully omitted, constitute dangerous propaganda. These suggestions originate from enthusiasts and faddists, whose conclusions have been based on incomplete analyses and careless observations of scattered groups of clinical cases. Review of their tabulated reports suggests that, in many instances, the cases are not true clinical manifestations of gas gangrene, that the time-honored and proved measures of surgery and therapy that have been used in conjunction with roentgenotherapy have not been considered, and that experimental work to support the efficacy of irradiation is altogether lacking.

In connection with other experiments on treatment of gas gangrene Cox and I have produced gas gangrene in the thigh wounds of guinea-pigs, and have subjected them to varying doses of roentgenotherapy at intervals of one to five hours after inoculation. In no case has it been possible to arrest the progress of the disease in closed wounds by the use of roentgenotherapy.

Gas Gangrene Experiments

Two drill-holes in femur; 0.15 cc. broth culture *C. welchii* implanted, wound closed primarily; irradiation one hour later.

Number of Pigs	Total Dosage	Avg. Time Survival
10	35 r.	41.4 hrs.
10	150 r.	40.6 hrs.
10	400 r.	25.4 hrs.
10	100 r.	32.9 hrs.
10 controls		25.6 hrs.

Although the experiments suggest that progress of the infection is retarded, they also indicate, paradoxically enough, that the smaller the dosage the better the effect. We have noted that roentgenotherapy in small doses at frequent intervals, is *not* sufficient to arrest a massive, early infection, does not even retard the fully developed infection, and is not more effective

than chemotherapy alone. These findings suggest that a surgeon would not be justified in subjecting a person with suspected or proved gas gangrene infection to roentgenotherapy to the exclusion of all other methods of treatment.

CONCLUSIONS

Reports in the literature pertaining to roentgeno- and chemotherapy which fail to consider all the factors concerned are not reliable.

Improved methods of estimating the degree of shock and loss of body fluids together with more prompt and efficient treatment make possible earlier débridement of compound fractures. The incidence of infections can, therefore, be diminished.

Tetanus antitoxin, as a preventive measure, will disappear as more of the military and civil population are immunized with tetanus toxoid.

Extensive preparation of the skin and wound with soap and water could be replaced by ether or iodine.

Immobilization of the fractured parts by traction during the stages of preparation and operation is desirable.

Implantation of sulfanilamide crystals in compound wounds is a valuable adjunct in preventing infection. Animal experimentation indicates that it has relatively little effect upon the progress of gas gengrene in closed wounds infected with *C. welchii.*

Internal fixation of fragments followed by closure is safe only in carefully selected cases operated upon by competent surgeons who possess a good armamentarium of instruments and equipment.

Postoperative fixation of open fractures in closed plaster encasements is objectionable and unnecessary. Adequate fixation which permits careful dressings can always be devised.

Sulfathiazole in pectin jelly forms ideal bland substance for dressing these wounds—it eliminates the odors, reduces the amount of discharge, and hastens healing.

The complication of gas gangrene can be recognized before it is revealed roentgenologically. The treatment is essentially surgical, with the use of sulfanilamide and antitoxin as adjuncts.

Roentgenotherapy, alone, has not yet proven its usefulness as a measure for arresting the progress of gas gangrene. Experimental work suggests that it has some inhibitory action under certain conditions.

REFERENCES

[1] Scudder, John: Shock; Blood Studies as a Guide to Therapy. J. B. Lippincott Co., Philadelphia and New York. 1940, p. 181.

[2] Murray, Clay Ray: In discussion of Heyl, J. H.: Compound Fractures of Long Bones. ANNALS OF SURGERY, 11, 470, March, 1940.

[3] Rogers, R. P.: The Use of Tetanus Toxoid in Private Practice. Bull. New York Acad. Med., 15, 553, August, 1939.

[4] Felcetti, J. C.: Compound Fractures. Med. Times, New York, 66, 472, October, 1938.

[5] Key, J. A., and Conwell, H. E.: The Management of Fractures, Dislocations and Sprains. 2nd ed., C. V. Mosby Co. St. Louis, 1937, p. 155.
[6] McMaster, P. E.: The Principles of Treatment of Compound Fractures. Am. Jour. Surg.. 38, 468, December, 1937.
[7] Ritter, H. H.: The Management of Compound Fractures. Arch. Surg., 34, 527, March, 1937.
[8] Boehler, L.: Treatment of Fractures. Wilhelm Maudrick, Vienna, 1929, p. 45.
[9] Watson-Jones, R.: Fractures and Other Bone and Joint Injuries. E. and S. Livingston. Edinburgh, 1940, p. 143.
[10] Orr, H. Winnett: Wound Infection and Compound Fractures. Illinois Med. Jour., 76, 71, July, 1939.
[11] Key, J. A., and Burford, T. H.: The Local Implantation of Sulfanilamide in Compound Fractures: Its Effects on Healing. South. Med. Jour., 33, 449, May, 1940.
[12] Jensen, N. K., Johnsrud, L. W., and Nelson, M. C.: The Local Implantation of Sulfanilamide in Compound Fractures. Surgery, 6, 1, July, 1939.
[13] Bohlman, H. R.: In discussion of Trueta.[17]
[14] Johnson, R. W.: In discussion of Trueta.[17]
[15] Watson-Jones, R.: Personal communication.
[16] Caldwell, Guy A.: Treatment of Gas Gangrene Experimentally Produced. In press.
[17] Trueta, J.: The Treatment of War Fractures by the Closed Method. Brit. Med. Jour., 2, 1073, December 2, 1939; Also Proc. Roy. Soc. Med., 33, 65, November, 1939.
[18] Odelberg, Axel: Surgical War Experiences. Nord. med., 5, 551, March 23, 1940.
[19] Thomson, J. E. M.: The Ten Commandments for the Treatment of Compound Fractures. J.A.M.A., 115, 1855, November 30, 1940.
[20] Meleney, F. L., and Johnson, B.: The Prophylactic and Active Treatment of Surgical Infections with Zinc Peroxide. Surg., Gynec., and Obstet., 64, No. 2A, 387, February, 1937.
[21] Kelly, J. F., and Dowell, D. A.: Roentgen Treatment of Gas Gangrene. Arch. Phys. Ther., 20, 88, February, 1939.

WAR WOUNDS OF THE NERVOUS SYSTEM*

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INFORMATION is not yet available for definite statements as to the incidence or character of injuries of the nervous system in the present war. Scant consideration has been given to injuries not caused by penetrating missiles in the medical records of previous wars for the obvious reason that such injuries were few in number compared with those produced by bullets, shrapnel and shell fragments. The traditional medical attitude that penetration is characteristic of war trauma was justified by past experience; but warfare is now waged by mechanized equipment and this is conducive to the production of injuries similar to those of transportation and industrial accidents in civil life.

An important activity of the present conflict is the aerial bombing of thickly populated areas of the belligerent countries, producing the greatest number of casualties among the civilian population. The bombing of cities will inevitably inflict serious injuries of the nonpenetrating type. The ratio of open wounds to closed injuries may show fluctuation according to the agencies and methods of military action. Many different types of injuries of the nervous system among the civilian population as well as the combatant forces will require the services of the modern army neurologic surgeon.

In the First World War, injuries to the nervous system were numerous, while the number of surgeons qualified to treat such injuries was small. During the past 20 years the field of neurologic surgery has developed rapidly, and with this development there has come a better appreciation and wider understanding among the medical profession of the problems of surgical neurology. The principles of treatment of injuries of the nervous system established during the First World War, with the added experience in the management of many thousands of injuries resulting from transportation and industrial accidents during the past two decades, can readily be applied to similar injuries produced in modern warfare.

In view of the voluminous literature on the management of closed injuries of the head and spine appearing since 1920, it seems unnecessary to make any reference to such injuries in this discussion, although injuries of this type may be numerous in modern warfare. Penetrating wounds of the brain and spinal cord are by no means rare in civil life, but since the appearance of the medical records of the First World War the literature has made little reference to such injuries. The purpose of this communication is to recall briefly the principles of treatment found to be effective in the manage-

* Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 1940.

ment of wounds of the nervous system in the First World War, with some discussion of the advances made through the application of these principles to similar injuries in civil life.

In a review of statistics of the last war, it is shown that of the patients reaching hospitals in one of the belligerent countries, approximately 25 per cent presented neurologic problems of one kind or another. Among the 174,296 battle injuries in the American Expeditionary Forces reaching hospitals, the head alone was involved in about 6 per cent, and of these, about 11 per cent resulted fatally. The delay in surgical treatment of penetrating wounds of the head, and lack of unanimity of opinion as to the best method of treatment were important factors in the mortality of casualties involving the head alone in the early period of the war. Another important factor in the mortality of head wounds was the frequent association of severe injuries in other parts of the body. In the early part of the First World War the operative mortality of gunshot wounds of the brain was about 60 per cent. This mortality was reduced to about 28 per cent by the operative methods advocated by Dr. Harvey Cushing. There has been no modification of importance in this technic of operation for gunshot wounds of the brain received either in warfare or in civil life since it was first proposed by Doctor Cushing.

War as waged to-day by some of the involved nations produces the greatest number of casualties at or near well-equipped hospitals, thus making possible early and adequate treatment regardless of the nature of the injury. The facilities for early and complete care of head injuries should be provided as far as possible in all phases of military operations, leaving only the very minor types of injury or those in shock to be cared for at the front line posts or First Aid Stations. Prompt transportation by airplane of soldiers with gunshot wounds of the head in field operations has been successfully used in some of the countries now engaged in war. In this connection, it has been stated that open wounds of the brain do not well tolerate elevation of more than 5,000 feet. Experience has shown that patients with head injury, when not in shock, stand ordinary transportation very well, and this also applies to patients in good postoperative condition. While every effort should be made to provide early operation upon penetrating wounds of the brain, a delayed operation at a station or hospital where complete surgical treatment can be provided is much better than an early inadequate operation. Adequate treatment of head injuries at advanced posts when transportation to a completely equipped hospital is impracticable may be provided by means of motorized surgical units. The prompt transfer of patients to base hospitals or the competent treatment at advanced posts by trained neurologic surgeons should bring about a definite reduction in the mortality of head injuries.

Open Wounds of the Brain.—Too much emphasis, perhaps, has been given to a time limit for operations on open wounds of the brain. It is highly desirable that these wounds should be operated upon within 16 hours if possible. However, many cases may be operated upon to advantage as

late as 48 hours or more, if obvious infection is not present. It is reasonable to expect that chemotherapy, promptly instituted in penetrating wounds of the brain, will increase the number of cases that may be benefited by later operation, and that the incidence of severe intracranial infection will be reduced by chemotherapy in all cases.

The treatment of head wounds at First Aid Posts should be limited to the control of external hemorrhage, treatment of shock, shaving the scalp, irrigation of the wound with saline or Ringer's solution, followed by the application of a sterile dressing and the administration of prophylactic tetanus antitoxin and some of the sulfonamide compounds. No effect should be made to remove bone fragments or other debris unless they lie loosely in the wound. Simple laceration of the scalp may be débrided and sutured at the First Aid Station provided there is no involvement of the skull and no evidence of intracranial injury.

When the patient with a penetrating wound of the head has been placed under conditions suitable for complete investigation, careful neurologic examination should be made, and the entire head shaved. There may be multiple bullet wounds of the scalp and each should be considered a potential brain wound until otherwise disproved. Tangential or gutter wounds of the skull are especially liable to cause severe brain damage by shattering fragments from the inner table of the skull. These fragments often penetrate the brain for a considerable depth. The effect upon the skull and the location of intracranial foreign bodies, such as indriven bone or metallic fragments, should be shown by roentgenograms, and the number of these foreign bodies checked with the number removed at subsequent operation. Restless patients may be given morphine preliminary to the use of local anesthesia by novocain injection of the scalp. Local anesthesia should be employed in every case if practicable. Sometimes the treatment of shock and the intracranial operation may be carried out simultaneously.

The fundamental objective in the treatment of penetrating wounds of the brain is the prevention of infection. Disinfection of a penetrating wound is accomplished by copious irrigation of the wound with saline or Ringer's solution, excision of the edges of the scalp wound, and careful removal of bone fragments, macerated brain tissue, blood clot, and foreign bodies whenever practicable. Chemical disinfection of fresh wounds should be discontinued in view of the superior results from mechanical disinfection with large quantities of saline solution. It may be necessary to enlarge the scalp wound by incisions, in order to give better exposure of the underlying wound of the skull and brain. Slight enlargement of the bone defect may be required, but it seems unnecessary to remove the fragments *en bloc*, unless the depressed fragments lie directly over one of the large venous sinuses. After removel of the bone fragments the wound should again be thoroughly irrigated. Large quantities of solution are required for thorough cleansing of these wounds. Macerated brain tissue is removed by irrigation through a catheter attached to a bulb syringe, supplemented by gentle suction through

a bent glass tube attached to the suction tip. By the use of irrigation and suction, alternately, the macerated brain tissue, blood clot and foreign bodies may be removed. Missiles which have passed beyond the midline of the skull from the point of entrance may be removed through a trephine opening made at a point most accessible to the missile, as shown roentgenologically. It may be possible, after removing the missile in this way, to effect a through-and-through irrigation for complete cleansing of the brain wound. Removal of débris from the brain wound will usually permit inspection of its depths, provided hemorrhage has been controlled and infection has not developed. Great care must be exercised in following the track of the bullet, in order to prevent further injury to brain tissue, and, in many cases, to avoid penetration of the ventricles. The devitalized brain tissue should be removed by suction down to the limits of normal brain. All foreign bodies should be removed when accessible, providing this is compatible with the protection of important functional areas. Bleeding vessels may be drawn up into the suction tip and coagulated with the electrosurgical unit, under direct inspection, made possible by the use of the lighted spatula. The addition of the suction apparatus and coagulation unit to the surgical equipment will do much to facilitate complete operation in penetrating wounds of the brain and to lower mortality. After thorough cleansing and complete hemostasis, the brain defect is filled with Ringer's solution. The dura should be closed securely without drainage unless there is some doubt as to the completeness of disinfection. The scalp is closed in layers, using interrupted fine silk sutures. Drainage of the scalp wound is unnecessary.

When there is evidence of infection the operation must, of necessity, be a limited one. Easily accessible bone fragments may be removed, the opening in the dura enlarged and drainage provided. The scalp wound should be packed with vaselinized gauze, and not sutured. The resulting brain fungus should be protected by a rubber dam over which is placed a doughnut ring of gauze.

The prevention of infection by thorough removal of devitalized brain tissue, blood clot and foreign bodies will minimize the subsequent scar tissue formation, thus decreasing the chances of epilepsy.

The surgical management of compound fractures of the skull with dural laceration is similar in principle to that of penetrating gunshot wounds of the brain. Reliance is placed upon careful mechanical disinfection of the wound with thorough débridement of the scalp, removal of bone fragments, blood clot, and damaged brain tissue. The dura is closed without drainage. Patients with compound depressed fractures of the vault, with laceration of the brain, are often in surprisingly good condition and early operation may usually be undertaken. In civil life such fractures are often very inadequately treated, and extensive local infection of the brain is a common result.

Injuries of the Spinal Cord.—The results of treatment of penetrating spinal cord injuries in the First World War were very discouraging. Approximately 80 per cent of all patients with spinal cord injuries died within

the first few weeks. This was due in part to severe associated injuries, but there was also a high mortality from sepsis arising either from bed sores or urologic infection, or both. These results were not unexpected and, unfortunately, may not be greatly altered in any future conflict in which early transfer of patients to adequate hospital facilities is impracticable.

In all types of spinal injuries, proper handling of the patient is of greatest importance, in order to avoid damaging the cord or increasing the damage of an existing cord injury. Penetrating wounds of the spine may require operation for the purpose of disinfection or for the removal of the penetrating agent in partial lesions of the cord. The cord lesion may be physiologically complete from the concussional force of the penetrating missile even though the cord itself has not been hit. Many such cases recover function in a short time with little residual impairment, while in others the cord may be completely disintegrated by the concussion. Practically all that can be accomplished by operation in gunshot wounds of the spinal cord is the disinfection of the wound and removal of fragments of bone and foreign bodies which rarely cause compression.

At the U. S. A. Hospital, No. 11, Cape May, N. J., following the First World War, there was a small number of gunshot wounds of the spinal cord showing varying degrees of spinal cord impairment. In some of these cases the patients suffered intractable pain for which cordotomy was performed. The general condition of such patients was usually very bad, due to sepsis and long-continued suffering. This series was probably among the first group of cordotomies performed by Dr. Charles H. Frazier.

Peripheral Nerve Injuries.—The records of Base Hospitals, according to Davis and Pollock, show that 14 to 16 per cent of all wounds to the extremities in the American Expeditionary Force, caused injuries of the peripheral nerves; and it was estimated that wounds of the peripheral nerves constituted 4.5 per cent of all casualties. The larger number of these injuries were operated upon many months after the wounds were received and, although the final results of operation were not accurately ascertained in any considerable number of cases, analyses of end-results of small groups indicated that recovery of function was very incomplete. Débridement of deep wounds by inexperienced surgeons was evidently responsible in some cases for injury to the nerve which had escaped injury from the missile. Operations for nerve suture were delayed until after fibrosis had replaced normal muscle tissue, particularly in the intrinsic hand muscles. Much time was lost by relying on misleading signs of nerve regeneration, such as Tinel's sign, which, at the time, was regarded by some as possessing a degree of infallibility.

Before the primary operation for repair of deep wounds of the extremities, a neurologic examination should be made, in order to determine whether there is involvement of important nerves. The disinfection and débridement of such wounds, when nerve impairment is probable or evident, should be undertaken by those competent to expose, identify and suture a divided nerve at the time of the primary treatment of the wound. Early suture of a divided

peripheral nerve is desirable. Chemotherapy may be utilized to prevent or retard infection.

In patients with paralysis of a peripheral nerve, when the condition of the nerve was not ascertained at the time of the repair of the wound of the extremity, the type of nerve lesion should be investigated at open operation as soon as the local condition of the wound will permit. It is advisable to wait three months after healing of an infected wound before exploration and suture of the nerve, but it is important that infection be eradicated as early as possible so that later suture may not be delayed longer than absolutely necessary. If infection develops after primary suture of a nerve, it is often advisable to excise the suture line and resuture the nerve after the infection has been eradicated. Peripheral nerve lesions are often associated with injury to important blood vessels of the extremities, and this, undoubtedly, contributes to unsatisfactory end-results.

Physiotherapy and proper splinting are essential adjuncts to the successful treatment of peripheral nerve injuries. To obtain the best results, both should be started early and continued through the period of paralysis.

The attitude toward peripheral nerve lesions which have not been adequately dealt with at primary operation, should be one that encourages direct inspection of the nerve, so that an early decision may be arrived at as to the type of treatment the nerve itself requires. In other words, the attitude toward operation for the exposure of the nerve may well be radical, while the treatment of the exposed nerve lesion should incline to conservatism.

In the writer's experience at Cape May Hospital, which probably handled one of the largest groups of nerve injuries collected from the American Expeditionary Force, I was often impresed in delayed exploratory operation by finding complete division of nerves when repeated clinical examinations had appeared to justify the assumption that nerve function was recovering spontaneously. Such errors may be avoided by exploration of the paralyzed nerve when there is any doubt as to the type of nerve lesion present.

The exposure of peripheral nerves is a procedure of little difficulty to those familiar with anatomy of the extremities. Judgment may be critically tested in cases in which the nerve lesion is manifested by a neuroma in continuity. The conservative operation of neurolysis is often advisable in such circumstances. The protection of important branches of the injured nerve during the dissection, the excision of scar tissue from the nerve ends, accurate approximation of the nerve segments without tension or torsion, and careful hemostasis are essential details in a successful technic for nerve suture.

The use of autogenous transplants to bridge wide defects in peripheral nerves, has been, so far as I know, unsuccessful in every case. A novel method of repairing divided peripheral nerves has been suggested by Young and Medawar (Lancet, August, 1940). By their technic the divided nerve ends are held in approximation by a cuff of concentrated liquid plasma. The originators of the method, which, thus far, appears to be experimental,

claim that regeneration following this technic is superior in every respect to that of direct suture. The procedure, obviously, has decided limitations.

The facial nerve is sometimes paralyzed by gunshot wounds of the mastoid region. Facial paralysis resulting from such wounds usually requires anastomosis with another motor cranial nerve. The hypoglossal is preferred for this anastomosis. Traumatic lesions of other cranial nerves do not require surgical treatment.

Much was expected from the study of the large collection of peripheral nerve injuries resulting from the First World War. These nerve injuries were received in a space of a few months and were segregated in special hospitals with special staffs interested in the treatment of such injuries. The hospitals in which the patients were treated were well equipped surgically and provided with elaborate departments of physiotherapy and electrotherapy. Unfortunately, in the study of this large collection of nerve injuries no standardized criteria of recovery were formulated; and after the patients were discharged from the hospital there were no well directed efforts to determine the results of treatment. An unparalleled opportunity for definite information relative to nerve repair and nerve regeneration was, therefore, lost.

Under the most favorable conditions, regeneration of sutured peripheral nerves leaves much to be desired. The misdirection of fibers from the central stump cannot be prevented, although this may be minimized by accurate approximation of the nerve segments, without torsion. The defects of regeneration, shown by the straying of fibers from the central stump, greatly interfere with the results of suture of such important nerves as the ulnar and median.

Further research is needed on nerve transplantation, particularly in view of its almost universal failure in peripheral nerves, and the good results claimed for transplantation in facial nerve defects. It is also important to have further information on the relative effects of early and delayed suture in the final recovery of function, and after what length of time can no further benefit be expected from surgical treatment of divided nerves. The technic of nerve repair, the treatment of neuroma in continuity, the effects of neurolysis—all present problems which are by no means settled and are worthy of further study.

It is absolutely essential that standardized criteria of partial or complete recovery be formulated, if actual knowledge is to replace mere impression as to the regeneration of injured peripheral nerves. These criteria should be applied in determining the end-results of treatment of every peripheral nerve.

DISCUSSION.—DR. JOHN S. MCEWAN (Orlando, Fla.): I had a large hospital in France during the World War before the Americans went over, and I wish that we had had you specialists there at that time. We had to do surgery from the top of the head to the bottom of the feet. If Doctor Blair had been there to see the plastic work by the French, he would have been amazed. They really did some very remarkable plastic surgery on the face.

Far be it from me to discuss nerve surgery. I suppose we had many hun-

dreds of nerve suturings, but I have never seen them since operating, so the results we obtained are not known. In a large percentage of cases, these injuries were due to compound fractures, with loss of bone and nerve. After these cases came from the front and the wounds healed, bone was grafted and then followed suture of the nerves.

This reminds me of a true story of a Colonel in the army. In this case, the Colonel could not find the proximal end of the nerve in the arm, and he worked on it for hours, and still could not find it. Finally, he picked up a piece of fascia and started to suture it to the distal end of the nerve. A young doctor from Savannah said to him, "Colonel, that is not nerve; that is a piece of fascia." The Colonel replied, "When I say it is nerve, it is nerve"—and continued to suture it.

It was the dirty clothing in these gunshot wounds that gave us our worst infections. We picked out pieces of shirts and clothing that had been worn for weeks. It was not the shrapnel that caused the most serious infections, it was the contaminated clothing.

We found that the brain operations should be undertaken early, and I believe the best results we had were in those cases operated upon within the first ten days.

Speaking of chemotherapy, three weeks ago we had a lot of Negro orange pickers, who had been riding in a truck that was wrecked. Twelve of them were brought to the hospital. Among this number were three with fractures of the skull, two of them compound, with depressed fragments. They were full of dirt, sand, grass, and cockleburs, and one had brain tissue extruding through the wound. We operated upon these two compound fractures, raising the fragments, and then dusted sulfanilamide all over and in the wound, sutured them without drainage, and got a primary union in both cases.

ABDOMINAL INJURIES*

PREVENTIVE AND PROPHYLACTIC ASPECTS

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THE DESTRUCTIVE CHARACTER of abdominal injuries incurred in the various theaters of modern warfare, as well as the increased difficulties of collection, transportation, and treatment of abdominal casualty cases have, to a great extent, counteracted the advances in methods for treating these war injuries. The multiplicity and anatomic destructiveness of most of the present wounds is incompatible with life, and even the injuries which are not inevitably fatal are usually so serious that survival of the patient is dependent upon the employment of every appropriate aid, both nonoperative and operative.

The situation which exists, in respect to abdominal injuries, in the present war was revealed in the discussions which followed the presentation of a paper by Kenneth M. Walker[1] concerning the protection of the soldier in warfare, before the Section of Surgery of the Royal Society of Medicine of England on June 26, 1940. This paper was discussed by prominent English surgeons, who presented data based on their own war experience or gained from others. Colonel A. E. Porritt[2] said that before the English forces left France in the present war, there were over 2,000 cases in Base Hospitals, and that he did not believe that there were among them a dozen chest or abdominal wounds, thus providing ample confirmatory evidence of the high mortality in such cases. While agreeing with Colonel Max Page[3] as to the enormous number of wounds which were due to missiles of low velocity, he commented on the marked relative increase in through-and-through wounds from machine and "Tommy" guns, seen in the latter weeks of the campaign in France. At the same meeting, Zachary Cope[4] read a note from a Major Underwood,[5] who stated that he was of the opinion that quite a number of the wounds seen during the present war were due to small, low velocity or medium velocity projectiles (Fig. 1). Major Underwood had remarked on the size of the fragments as compared with those in the last war. The feasibility of protecting soldiers from, at least, low velocity projectiles was generally agreed upon, and opinion was almost unanimously in favor of some sort of body armor. The discussion concerned not only protection of the abdomen and chest, but included consideration of protective appliances for other parts of the body. The need for protection of the abdomen was particularly emphasized. At this meeting, the following resolutions were carried unanimously:

"(1) That this representative meeting of the Royal Society of Medicine,

* Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

after a full discussion of the question, is emphatically, of the opinion that the physical protection of the members of the fighting force can and should be improved by a closer collaboration between the medical profession and the appropriate technical experts of the Admiralty, War Office, and Air Ministry;

"(2) That this meeting of the Royal Society of Medicine resolve that the Council of the Society be asked to consider the formation of a special committee to this end, according to by-law 21; furthermore, as the matter is, in the opinion

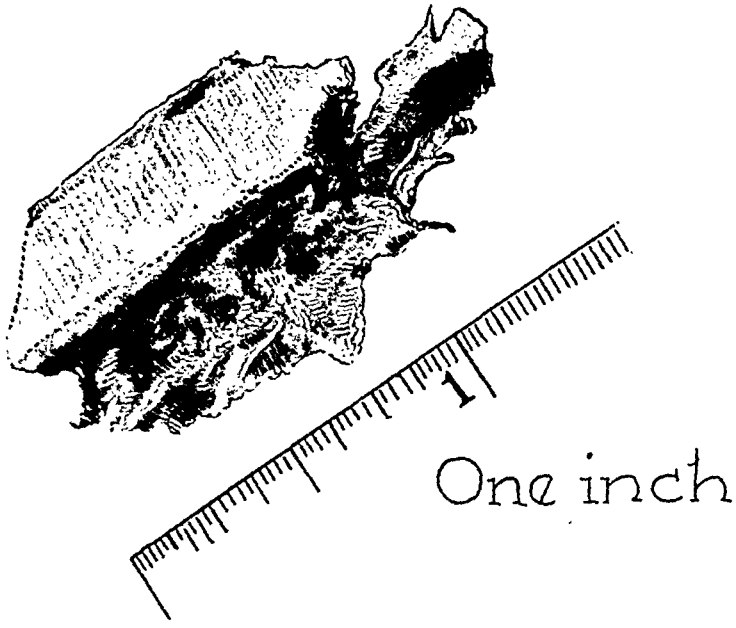


FIG. 1.—Fragment of English high explosive shell from present European war.

of this meeting, one of extreme urgency and importance, it is hoped that the President may use his emergency powers and approach the Government with the offer of the Society's cooperation at the earliest possible date."

The present review of abdominal injuries will be limited to a general consideration of the methods, especially certain newer ones, for reducing the incidence of, and ameliorating the serious nature of abdominal injuries. Specific injuries, and details of treatment such as were included in a paper[6] presented before this Society last year, will be omitted.

The preventive and prophylactic problems which will be discussed are as follows:

(A) Preventive Problems
 (1) Reduction of total number of war wounds.
 (2) Reduction of extent of individual wounds.
 (3) Reduction of multiplicity of wounds in an individual.

(B) Prophylactic Problems
 (1) Prevention and prophylaxis of infection.
 (a) Peritonitis
 (b) Wound infection
 (2) Prophylaxis and early treatment of shock.
 (3) Adequate treatment of hemorrhage.

The methods whereby these problems may be at least partially solved are as follows:

PREVENTIVE MEASURES.—Although complete prevention of abdominal injuries is obviously impossible, there are means of substantially reducing the total number as well as the extent and multiplicity of these wounds.

Education of Armed Forces and Civilians.—Education concerning precautionary measures to be taken both by armed forces and civilians will materially reduce the incidence of abdominal injuries. Many of the injuries which can be prevented by this means are caused by bricks, pieces of cement or concrete, timber and structural steel hurled from buildings, streets, or roads which have been bombed.

Airplane and Artillery Raid Shelters.—The need for adequate shelters for protection against air-raids and artillery fire is fully recognized and requires no detailed discussion. The difficulty encountered in persuading people to avail themselves of these facilities is well-known to everyone from accounts in the daily newspapers. The full benefits which may be achieved by this sort of protection are dependent upon adequate public education.

Armor for Vehicles and Equipment.—The inclusion of protective shields as parts of field guns has long been customary. Motorized equipment, such as motorcycles and trucks, in which troops are transported are likely to be objects of attack, either by air or from the ground and, insofar as it is possible, armor protection should be included in the construction of this type of equipment. In the instance of motorcycles, windbreaks for the protection of the head, chest, abdomen, and legs can be incorporated without difficulty. Armor-lined airplane cockpits have been found effective in saving pilots and gunners, not only from injuries by projectiles but from burns.

Body Armor.—Most attempts to gain acceptance of body armor as standard equipment have met with passive or active resistance by authorities, who either considered the matter not worth discussing or who advanced what they considered irrefutable objections to its use. It is interesting to know that for some time following the acceptance of the steel helmet, now considered indispensable, this innovation met with much adverse criticism.

Various arguments which have been advanced for and against the use of body armor are as follows:

Against:

(1) Adds too much weight to equipment.
(2) Decreases freedom of motion.
(3) Deforms bullets.
(4) Ineffectual against high velocity direct axial hits.
(5) Unacceptable to soldier.
(6) Insufficiently tried.

For:

(1) Abdominal wound almost invariably fatal.
(2) Weight requirements met by new light metals.

(3) Motorized equipment has increased feasibility.
(4) Arrests most low velocity projectiles.
(5) Deflects many high velocity projectiles.
(6) Most injuries due to oblique hits by small, low velocity projectiles.
(7) Improves morale.
(8) Increases efficiency.
(9) Conserves man-power.
(10) Humane.
(11) Releases equipment and men.
(12) Reduces replacement-requirements.
(13) Relieves congestion on roads.
(14) Used by invaders during recent conquest of Belgium.



FIG. 2.—Body armor for protection of chest and abdomen (after Kenneth M. Walker[1]).

Most present-day war casualties are caused by missiles of low velocity, roundly, those traveling at a rate of less than 1,000 feet per second, to which the lightest type of helmet and armor is proof. Extremely convincing evidence in favor of body armor is the fact cited by Walker,[1] that it was used by the invaders during the recent conquest of Belgium. A type of armor which has been given consideration for use by the United States army is shown in Figure 2.

If it were known to an enemy force that their opponents were only protected

by armor covering the chest and abdomen, all accurate firing would be directed at the unprotected areas. It is, therefore, suggested that a jerkin-type of armor might be designed in which the rear half would be made in detachable sections, which could be shifted to pockets in the front or back of trouser legs or sleeves to afford protection to thighs, legs, and upper extremities as circumstances indicate. Because the weight carried by troops is so important, as much as

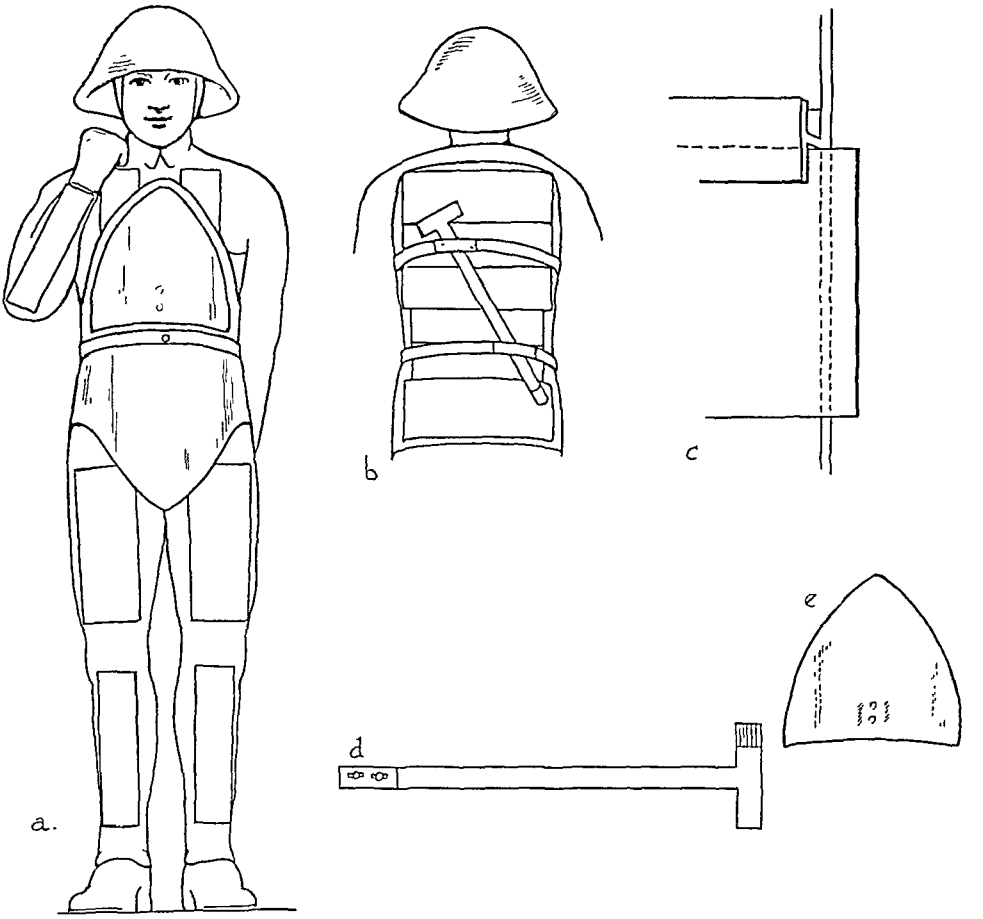


FIG. 3.—Suggested type of body armor. (a) Front view. (b) Posterior element, with removable sections which might be slipped into "pockets" for protection of upper and lower extremities. (c) Construction detail of posterior element. (d) Shovel handle, to be used as water canteen. (e) Removable portion of breast plate which might be used as entrenching shovel blade.

possible of the essential equipment, *i.e.*, shovel, canteen, *etc.*, should be incorporated into the body armor; for instance, the shovel blade could constitute part of the chest armor, and a further reduction in the total weight of equipment could be accomplished by using a hollow metal shovel handle as a canteen. Figure 3 is a diagrammatic representation of a body armor arrangement herewith suggested as adaptable for affording a wide range of protection without undue increase in weight.

The materials which have most often been suggested or tested in respect to their suitability for body armor include: Chain mail; wire mesh or net; sheet metal, notably manganese steel, chromium steel, silicon nickel steel; aluminum

alloys; rubber; laminated metal and rubber; woven silk; cork; compressed canvas; leather; asbestos; paper; cotton; rayon; bakelite and other plastics; miscellaneous fibers, hemp, sisal, hair, flax, kopak, balata.

The increasingly fatal nature of war wounds, the development of acceptably light yet resistant metals, and the feasibility of equipping troops with body

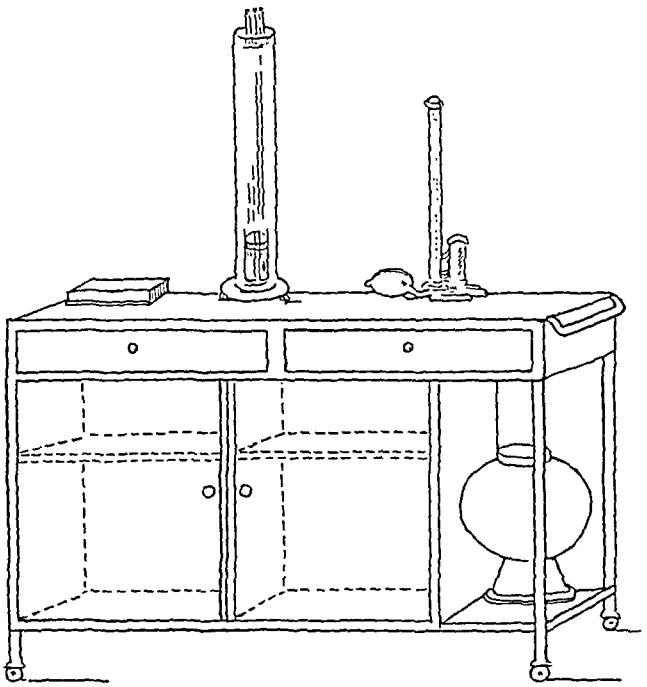


FIG. 4.—Portable "shock cart" which includes apparatus and supplies for studying and treating shock and hemorrhage. Indicated on top are pieces of apparatus for falling-drop estimations, blood cell counts, and blood pressure determinations. Centrifuge at base on right is for mean corpuscular volume studies. The drawers contain syringes, sterile linen, and direct transfusion equipment. The compartments below the drawers contain preserved plasma, serum, or whole blood; saline and glucose solutions; tubing and drip meters; and drugs.

armor when transportation is motorized, is leading to adoption, in some form or other, of this form of protection.

PROPHYLACTIC MEASURES.—Prophylactic measures will be considered in two categories: (1) Those which may be instituted in anticipation of possible injury; and (2) those which have to do with the care of patients after abdominal injury has been sustained.

Before Injury Is Incurred.—Precautions which may be taken, and methods of preparation which will be considered for possible employment in anticipation of abdominal injuries, include evacuation of the large bowel and abstinence from food shortly before anticipated injury, and methods for killing or replacing pathogenic bacteria normally present in the intestine.

The advantage of having the large bowel and the stomach as empty as is possible at the time of an abdominal injury is obvious, and civilians as well as troops should be advised to evacuate the bowel and avoid eating at times when they are likely to be wounded in the abdomen.

The possibility of killing bacteria in the intestinal tract by the oral adminis-

tration of sulfanilylguanidine[7] immediately brings to mind the possibility of preventing or reducing the severity of peritonitis by administering this drug to civilians or members of the armed forces when it is known beforehand that they are to be exposed to the danger of abdominal injury. The practicability of such preparation would depend upon the toxic effects and impairment of efficiency caused by the administration of the drug.

It has been shown,[8, 9] that it is possible to practically eliminate the pathogenic organisms normally present in the intestine by feeding cultures of Lactobacilli either alone or in conjunction with a diet which facilitates the transformation of the intestinal flora. It is conceivable that elimination of pathogenic organisms from the intestinal tract by this method might, at least, considerably reduce the severity of peritonitis following penetrating abdominal wounds. Since this method of ridding the intestine of pathogenic bacteria not only does not impair nutrition, but causes no toxic effects, it would be, if equally efficacious, superior to the sulfanilylguanidine method of intestinal preparation. Experimental investigations, in pursuance of this idea, are in progress in the Department of Surgery at Tulane.

After Injury Is Incurred.—After an abdominal injury has been incurred, rapid transportation of the patient to an hospital unit is of vital importance. Insofar as rapid evacuation to an hospital unit minimizes shock and hemorrhage, transportation facilities must be considered in the category of prophylactic measures. The disruption of facilities for evacuating casualty cases is exaggerated by the speed and wide range of modern warfare, and is a prime factor in increasing the mortality associated with abdominal wounds. The destruction by airplane bombing of railroads or highways already congested by refugees, is likely to bring ground level transportation equipment to a standstill. In order to avert the disastrous results of delay in abdominal casualties, adequate provisions must be made for transfer by airplane whenever possible. As in the instance of motor ambulances, ambulance train coaches, and airplane ambulances should be heated, and ambulance trains should be equipped for the treatment of shock by modern methods en route to hospitals out of the combat zone. Under some circumstances, older types of equipment such as horse-drawn ambulances might, even now, afford a more rapid or gentle means of evacuating the wounded over open or rough country when blocked roads stop the movement of motorized ambulances.

Motorized mobile hospital units which afford operating facilities must be placed as near the front as is compatible with efficiency, and enough of this sort of equipment must be provided to adequately care for the urgent demands which are likely to be made on it for the care of large numbers of casualties.

Infection involving the peritoneal cavity and its contents as well as the abdominal wall wound remains a serious problem in those cases who survive long enough to develop these complications. Fortunately, however, the demonstrated beneficial effects of the sulfonamide drugs, administered through various routes, is encouraging and this form of therapy should be promptly instituted. The prophylactic value of transfusions of blood or plasma, and the administra-

tion of cevitamic acid is well established in the treatment of infections of either the peritoneum or abdominal wall.

Advances in knowledge concerning the treatment of peritonitis gained in civil practice, including the proper supplying of fluid and mineral requirements, the use of the Miller-Abbott tube, the administration of large doses of morphine, *etc.*, find direct application in the prophylaxis or early treatment of peritoneal infection complicating abdominal injuries.

The benefits accruing from the early application of established principles in the treatment of wound infection, *i.e.*, débridement, wound drainage, and immobilization, may in some instances be increased through the prompt administration of appropriate antisera.

In the instance of infections due to the micro-aerophilic hemolytic streptococcus, the value of the zinc peroxide paste, advocated by Meleney,[10] seems to be adequately established not only in the treatment of already established areas of infection, but as a means of preventing extension of the inflammatory process.

The use of nonabsorbable suture material, in order to avert or reduce the incidence of serious wound infection and wound disruption, must be included in the category of preventive measures applicable in the management of wounds due to abdominal injury. Adequate drainage of the abdominal wall wound may prevent the development of an intramural abscess, which, by rupturing into the peritoneal cavity, can cause death.

Prophylactic roentgenotherapy, for the purpose of reducing the incidence of gas bacillus infection, has been advocated and employed in many instances, particularly in wounds of the extremities. Although this therapeutic measure might be of some prophylactic value in war wounds of the abdomen, definite information in this respect is not available.

Reports concerning the value of miscellaneous antiseptics for the prophylaxis of wound infection must be subjected to critical estimation.

For the prevention as well as the treatment of shock, the benefits afforded through the early institution of means to provide adequate rest and maintain body heat should not be lost sight of due to enthusiasm over newer additional methods. Under the trying conditions of war, when other forms of treatment are oftentimes not possible, almost entire reliance must frequently be placed in simple methods, as securing rest and preserving body heat. On the other hand, when time and facilities allow, determination of specific gravity changes in the blood by means of the falling-drop method[11] makes possible the early detection of shock and prompts the institution of therapy before the irreversible deleterious effects of prolonged shock have occurred. The importance of the early administration of blood plasma in conjunction with adrenal cortical hormone and hypertonic sodium chloride solution, as advocated by Scudder,[12] and others, is now generally accepted and constitutes a great advance in the prophylaxis and treatment of shock. The administration of 100 per cent oxygen has also been shown to be of value both in averting and treating shock. Apparatus such as the Boothby-Lovelace-Bulbulian[13,14,15] mask, and the intranasal catheter method have increased the practicability of this type of therapy.

The direct relationship between the amount of hemorrhage and the mortality in penetrating wounds of the abdomen, graphically shown in Chart 1, is based on observations in a series of personal cases, and is in accordance with the findings of others. Since hemorrhage is such an important factor as a cause of death following abdominal injuries, the value of early administration of adequate amounts of whole blood or plasma is apparent. The remarkable developments

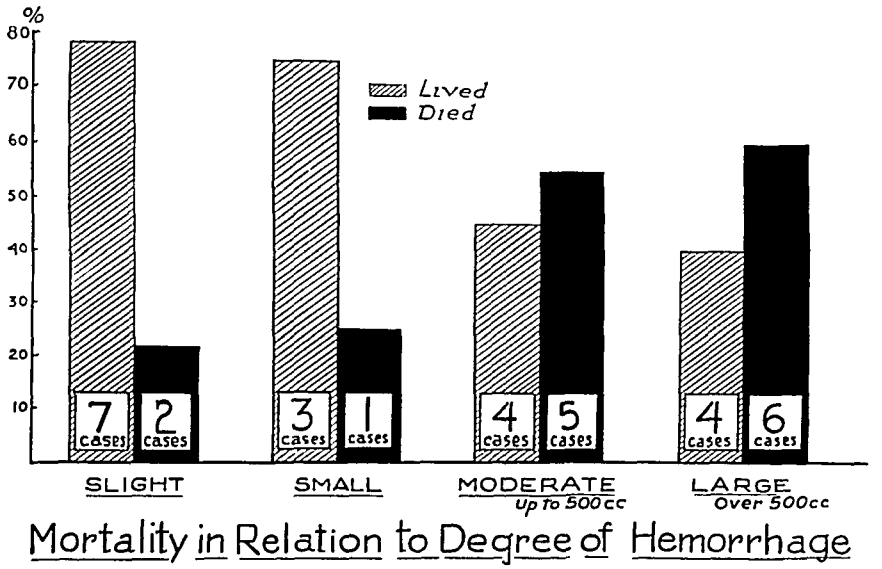


CHART 1.—Showing relationship between amount of hemorrhage and mortality in the author's personal series of penetrating wounds of the abdomen

which have occurred within the last several years in respect to the transfusion of whole blood and especially the demonstration of the benefits derived from the administration of fresh or preserved blood or of various blood elements, have greatly advanced the treatment of hemorrhage, and shock due to hemorrhage. There have been numerous critical reports concerned with the relative merits of pooled plasma, preserved whole blood, dried serum, and fresh whole blood. For the treatment of shock unassociated with considerable hemorrhage, pooled plasma seems to be superior to other types of blood transfusion. When shock is associated with hemorrhage, pooled plasma may again be employed to advantage, especially if fresh whole blood is not available. If the full benefits which may result from the transfusion of whole blood or various blood elements are to be attained, it is necessary that these substances be given promptly and in sufficiently large amounts. The delayed administration of even large transfusions is ineffectual in reversing the deleterious effects of prolonged shock. The production by Smith, and his coworkers[16] of a potent preparation of thrombin, capable of causing practically instantaneous clotting when applied to a bleeding surface, suggests the present possibility of promptly arresting bleeding from torn liver surfaces by means of this substance.

SUMMARY

The destructive and complicated character of abdominal wounds incurred in modern warfare, and the difficulty of quickly transporting these casualty cases, is responsible for an appallingly high mortality rate, and is forcing the

consideration of abdominal injuries from the preventive and prophylactic standpoints. Fortunately, there are methods whereby not only the present number of immediately fatal injuries can be reduced, but there are also means whereby more of the less seriously injured abdominal casualty cases may be saved.

Preventive measures, for the reduction of the total number of injuries, include education in respect to precautions that should be taken by armed forces and civilians at times when the danger of incurring abdominal injuries can be reasonably anticipated, the provision of adequate shelters for protection in case of airplane or artillery raids, armor protection for vehicles and equipment, and adoption of some type of body armor.

Of the prophylactic measures for the reduction of the serious consequences and complications of abdominal injuries, some may be instituted beforehand, while others are applicable after injury is incurred. Measures which may be employed, before injury is incurred, are concerned with reducing the incidence or severity of peritonitis resulting from perforation of the hollow alimentary tract viscera. Measures which may be employed, after injury is incurred, are concerned with avoidance of delays in evacuation due to inadequate transportation facilities, the use of motorized mobile hospital units, the application of advanced knowledge concerning the treatment of peritonitis and wound infection, and the supplementary employment of methods for the study and treatment of shock and hemorrhage.

REFERENCES

[1] Walker, Kenneth M.: The Protection of the Soldier in Warfare. Proc. Roy. Soc. Med., 33, 607, 1940.

[2] Porritt, Col. A. E.: Discussion of Walker.[1]

[3] Page, Col. Max: Discussion of Walker.[1]

[4] Cope, V. Zachary: Discussion of Walker.[1]

[5] Underwood, Major: Cited by Zachary Cope in discussion of Walker.[1]

[6] Storck, Ambrose H.: Penetrating Wounds of the Abdomen; an Analysis of 46 Personal Cases. ANNALS OF SURGERY, 111, 775, 1940.

[7] Marshall, E. K., Jr., *et al.*: Sulfanilylguanidine (Sulfanilamide Derivative); Chemotherapeutic Agent for Infections. Bull. Johns Hopkins Hosp., 67, 163, 1940.

[8] Bass, C. C.: Personal communication.

[9] Rettger, Leo F., and Cheplin, H. A.: A Treatise on the Transformation of the Intestinal Flora, Yale Univ. Press, 1921.

[10] Meleney, Frank L.: Treatment of Traumatic Wounds with Zinc Peroxide. New York State Jour. Med., 39, 2188, 1939.

[11] Barbour, H. G., and Hamilton, W. F.: Blood Specific Gravity; Its Significance and a New Method for Its Determination. Am. Jour. Physiol., 69, 654, 1924.

[12] Scudder, John: Shock: Blood Studies as a Guide to Therapy. Philadelphia, Lippincott, 1940.

[13] Boothby, W. M.: Oxygen Administration; Value of High Concentration of Oxygen for Therapy. Proc. Staff Meet., Mayo Clinic, 13, 641, 1938.

[14] Lovelace, W. R., II: Oxygen for Therapy and Aviation; Apparatus for the Administration of Oxygen or Oxygen and Helium by Inhalation. Proc. Staff Meet., Mayo Clinic, 13, 646, 1938.

[15] Bulbulian, A. H.: Design and Construction of Masks for the Oxygen Inhalation Apparatus. Proc. Staff Meet., Mayo Clinic, 13, 654, 1938.

[16] Smith, H. P.: Blood Clotting and the Control of Hemorrhage. Tr. Kansas City Acad. Med., 1937–1939, pp. 243–264.

AIDS IN AVOIDING SERIOUS COMPLICATIONS IN THYROIDECTOMY*

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TO WRITE under such a title as the above, at least two assumptions are necessary: (1) That all of the serious complications, here discussed, have occurred several times to the one who suggests methods to avoid them; and (2) that the methods suggested to avoid them have been employed not once or twice but in a sufficiently large series of cases that one can, with the faith established by this experience, confidently recommend their employment. A third postulate could reasonably be required of a writer on this subject, namely, that definite evidence in the way of mortality rates in a large series of cases be adduced to demonstrate that real results had been accomplished by the employment of these measures.

In a very large series of thyroid operations, practically every possible complication which could arise has occurred, not once but, of necessity, a great many times. With increasing experience, with increasing facilities, mechanical and laboratory, and with an increasing number of minds in the group applied to these problems, the methods here discussed have been developed and so applied that, in the entire series of 19,700 thyroid operations, the mortality rate is only 0.76 per cent.

One of the most serious and constant complications in thyroid surgery is that of thyroid reaction, sometimes called thyroid crisis or thyroid storm. When these reactions follow surgical procedures they are most often due to not having appreciated, preoperatively, the intensity of the hyperthyroidism, the seriousness of the risk and the probability of the degree of postoperative reaction. There is one definite aid in this condition which is often overlooked and which will do a great deal to avoid this mistake. If, when the patient is seen at his first visit to the hospital, clinic or physician's office, a note is recorded on his history as to whether or not, because of the intensity of his intoxication, more than a one-stage procedure will be necessary, it will avoid, in many instances, the possibility of the mistake of undertaking too much surgery upon a patient who is too bad a risk. Unless one records this impression when the patient is first seen, he may well be put to bed, put upon a high carbohydrate diet, on Lugol's solution, often with intravenous glucose solution, and again seen by the surgeon who is to operate upon him a day or two before the operation is undertaken with the purpose of settling at that time as to whether or not graded procedures are to be employed. When patients are seen after seven or eight days' rest in bed

* Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

and preparation, and the decision made then, the interpretation of the hazards of the procedure is often not a justifiable one. What one needs to remember is that immediately after the operation the patient will be as bad as he was when first seen at his worst, or in even a greater degree of thyroid reaction. If there be on the patient's record the warning that the operation should be performed in two or three stages, and, under the anesthetic while the operation is being performed, there be evidences of considerable reaction, these two points will lead one to limit the procedure to a less extensive one than a complete subtotal thyroidectomy.

We have repeatedly stressed what we have learned from a large clinical experience, that the three outstanding factors which indicate surgical hazards in operation upon a patient with a toxic thyroid are—age, weight loss, and the length of time they have had the disease. Older people stand thyroid toxicity and postoperative thyroid reaction distinctly less well than do younger people. Weight loss, when occurring without dietary measures, is a direct indication of the prolonged effect of an elevated metabolism, and one must realize that not only does the weight loss occur, but prolonged diminution in the protective elements in the liver likewise occurs as the result of this positive metabolic imbalance. The length of time which patients have had hyperthyroidism is likewise an indication of a possible serious postoperative reaction because, as with weight loss, long-standing hyperthyroidism means long-standing postive metabolic imbalance with undesirable effects, particularly upon liver function, over this period of time.

There is nothing which can mislead one as to the possible degree of thyroid risk and possible postoperative reaction more than metabolic readings. This is particularly true because they are reported in percentage figures, and so, by those who are not dealing with thyroid disease daily, can be interpreted in degrees of risk in relation to the height of the metabolism.

High metabolic rates, if truly basal, undoubtedly are indicative of severe degrees of thyroid intoxication, but one can by no means assume that patients with relatively low metabolic readings will not at times have even more serious postoperative thyroid reactions than those with high basal rates. It is for this reason that it is extremely important to say that the height of the metabolism is by no means a trustworthy indication of the possible degree of the postoperative thyroid reaction.

As may be seen in Chart 1, we have found that the administration of glucose solution on the morning of the operative day, providing, as it does, something extra for the patient to burn during the hours of his temporarily stimulated metabolism, has distinctly decreased the degree of postoperative thyroid reaction in the patients with severe degrees of thyroid toxicity.

It seems unnecessary, to-day, to urge the relationship of multiple-stage operative procedures to low mortality rates in thyroid surgery. I would like to urgently stress the fact that states of thyroid toxicity vary in different individual practices, that they vary in different parts of the country and that no

plan of 100 per cent employment of one-stage operative procedures in thyroid surgery, as has been advocated by some, be accepted without very definite reservations by those practicing thyroid surgery in other parts of the country from where these series are reported.

Not only is it necessary, preoperatively, to arrive at some conclusions as to the degree of operative risk in relation to the possible postoperative thyroid reaction, but one often finds that decisions to limit the extent of the operative procedure must be made during the actual performance of the operation. It is of great importance, therefore, in patients upon whom there is any doubt as to the seriousness of their state of thyroid toxicity, that but one-half of the thyroid be uncovered, that only one hemithyroidectomy be completed, and the situation then reviewed as to the patient's immediate state and the decision made as to whether or not operation upon the other side should be undertaken at this time. An aid in determining not to proceed beyond a first-stage hemithyroidectomy in this uncertain situation is the amount of oxygen which the patient is consuming. A normal individual will consume approximately 250 cc. of oxygen per minute, while a patient with hyperthyroidism, during the operation, may consume up to 800 cc. per minute. When, therefore, patients are consuming a large amount of oxygen, this is a possible suggestion that no more than a first-stage subtotal hemithyroidectomy should be undertaken.

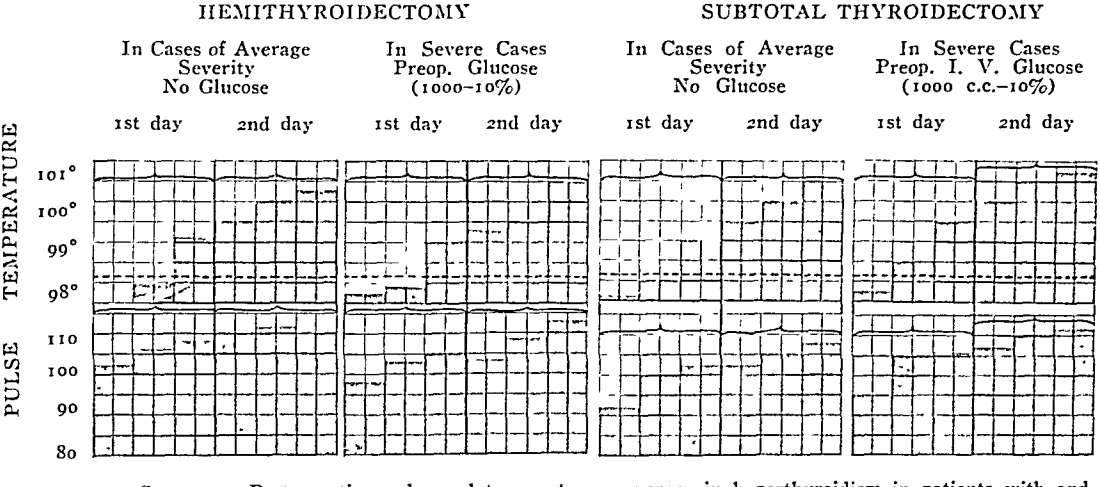


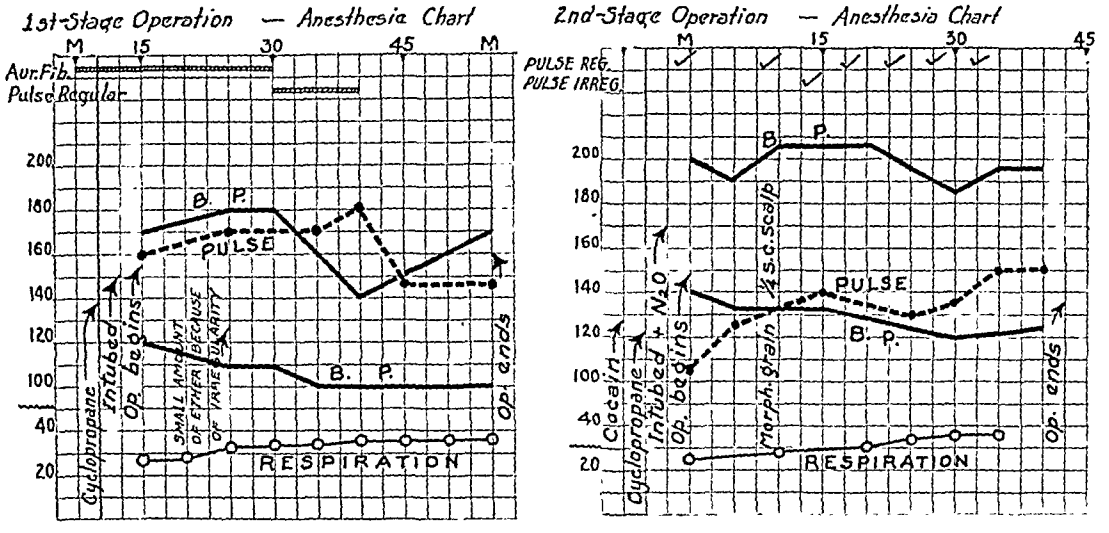
CHART 1.—Postoperative pulse and temperature responses in hyperthyroidism in patients with and without glucose solution on the morning of operation. Note in the severe cases that these patients who had had glucose on the day of operation had no more, or even less, reaction than the less severe cases in which glucose solution was not administered.

Pulse pressure is probably one of the best indications of the immediate degree of thyroid toxicity, and when, during the operation, the pulse pressure is gradually widening, this, likewise, is an indication of increasing thyroid toxicity and for a termination of the procedure by means of a first-stage subtotal hemithyroidectomy (Chart 2).

Another indication of possible postoperative thyroid reaction is a rising pulse rate and an increased demand for the amount of anesthetic. Those

patients whose pulses are progressively rising and who are requiring greater and greater depths of anesthetic mixture to keep them anesthetized are, likewise, candidates for first-stage hemithyroidectomy.

Still another indication of the intensity of thyroid toxicity is the degree



OPERATIVE FACTORS SUGGESTING MULTIPLE-STAGE OPERATION

1. Slight effect from premedication
2. High O_2 consumption
3. Widening pulse pressure
4. Persistent rapid or irregular pulse
5. Vasomotor instability

CHART 2.—Operative factors suggesting advisability of multiple-stage operation: (1) Slight effect from premedication; (2) high oxygen consumption; (3) widening pulse pressure; (4) persistent rapid or irregular pulse; and (5) vasimotor instability.

with which they react to the preoperative narcosis. Those patients who come to the operating room in active excitation, in spite of the preoperative administration of an adequate amount of narcotics, should be looked upon with suspicion as to possible postoperative reaction. The reverse, however, is not to be depended upon.

Perhaps nothing in the past has played a greater part in the production of undesirable complications in thyroidectomy than anesthesia. For practical purposes there are two types of anesthesia that may be employed for thyroid surgery: (1) Regional anesthesia which may consist of either local infiltration or cervical plexus block; and (2) inhalation anesthesia consisting of ether or one of the gaseous anesthetic agents such as nitrous oxide, ethylene or cyclopropane or various combinations of these. Mention is not made of avertin since it is generally combined with inhalation anesthesia and may more properly be considered as a preanesthetic drug.

We have always felt that local anesthesia interferes with the adequacy of thyroid exposure, and the delicacy of the anatomic dissection. In addition to that, we believe that it is a psychic burden upon the patient unless an amount of preliminary drugging is employed which practically amounts to a form of anesthesia. We have, likewise, always felt that undiluted ether is undesirable because of the struggling that is so often related to its induc-

tion and the nausea which so frequently follows its employment. The seriousness of prolonged postoperative vomiting for a patient with hyperthyroidism cannot be overemphasized. The serious disturbance of blood chemistry and the interference with the intake of fluid and fuel as a result of prolonged vomiting certainly tend to increase postoperative thyroid reaction, and have undoubtedly caused the balance to be swayed not infrequently on the side of a fatality.

Nitrous oxide anesthesia has some advantages in thyroid surgery. It is entirely nonexplosive and, as a rule, produces relatively little postoperative nausea and vomiting. It does, however, have a very great disadvantage (and this is of great importance to patients with hyperthyroidism) in the fact that nitrous oxide anesthesia alone is always associated with some degree of anoxemia. Since nitrous oxide is such a weak anesthetic drug, in order to maintain adequate anesthesia it is frequently necessary to carry patients with oxygen concentrations as low as 9 to 10 per cent.

Ethylene anesthesia offers some advantages over nitrous oxide. Like nitrous oxide, it is associated with relatively few instances of prolonged postoperative vomiting but, in contradistinction to nitrous oxide, it is quite explosive in almost all concentrations in which it is employed for anesthesia. Since it is a stronger anesthetic drug than nitrous oxide, higher concentrations of oxygen may be employed with it (approximately 15 per cent). We feel that this is still a rather low concentration of oxygen for patients with hyperthyroidism who are known to have increased metabolic rates.

Cyclopropane offers many advantages over either of the two above-mentioned gases. It is, as a rule, associated with very few disturbances in physiology. This gas is a very powerful anesthetic agent and may be administered in concentrations so low as to allow for concentrations of oxygen as high as 85 or 90 per cent. It does, however, have the distinct disadvantage of being explosive when mixed with oxygen, in practically all of the concentrations in which it is used for anesthesia.

Because of the fact that, for the above reasons, we have so often advocated the use of cyclopropane anesthesia for thyroid surgery we would like to utter a warning concerning its employment. As a result of further and more extensive experience with this agent, we should like to urge that it not be employed in an undiluted form in patients with thyroid toxicity or in patients with heart disease. It has been known for a long time that high concentrations of cyclopropane might produce cardiac irregularity, particularly in patients with thyroid toxicity, and is even more prone to do so in those patients who definitely have some degree of cardiac damage associated with their hyperthyroidism. We feel certain that fatalities on the operating table due to sudden cessation of heart action caused by ventricular fibrillation, associated with cyclopropane anesthesia, have occurred in our experience. As a result of these experiences we do not now employ this agent in an undiluted form for anesthesia in patients suffering from hyper-

thyroidism or heart disease. It is extremely important, I believe, to stress this point because of the popularity of this anesthetic agent.

Whenever a patient with serious hyperthyroidism is operated upon, the margin of safety is undoubtedly at times quite narrow. It must be accepted, also, that, at times, in this operation even the most experienced thyroid surgeon will meet with technical operative difficulties. It must, likewise, be admitted that even the most experienced anesthetist will also meet with



FIG. 1 (a) and (b).—These roentgenograms show the spiral-walled, flexible metal catheter introduced into the trachea. (a) Anteroposterior view; and (b) lateral view. Note in (a) the extent of the goiter and the deviation of the trachea. One can readily understand, in this type of large adenomatous goiter as well as in exophthalmic goiter, how manipulation to the trachea can be carried on with no interference with the airway.

anesthetic difficulties during thyroid operations. When these two difficulties, an interference with breathing producing anoxemia and technical difficulties, are combined during a thyroid operation, they can result in an operative fatality.

I will speak later about methods of avoiding technical operative difficulties. Anesthetic difficulties in the way of interference with breathing can absolutely be avoided by the introduction of a noncollapsible intratracheal catheter before the operation is undertaken. This requires but little time, and, in the hands of an anesthetist expert in its employment, can be accomplished with no difficulty whatever. It insures a complete airway at all times, complete quietness of the field, and the elimination of at least one of the serious possible complications of thyroidectomy (Fig. 1).

Many thyroid deaths are undoubtedly the result of technical operative complications. These result in prolongation of the operation, inadequate control of bleeding, interference with anatomic relations, and undue loss of blood. They result in injury to the parathyroid bodies, injuries to the nerves, and at times even in injury to the trachea. If two principles are

observed, there should almost never be serious technical operative difficulties in performing a thyroid operation: The first is adequate exposure—the pre-thyroid muscles cut, the skin flap dissected high, the venous blood supply,

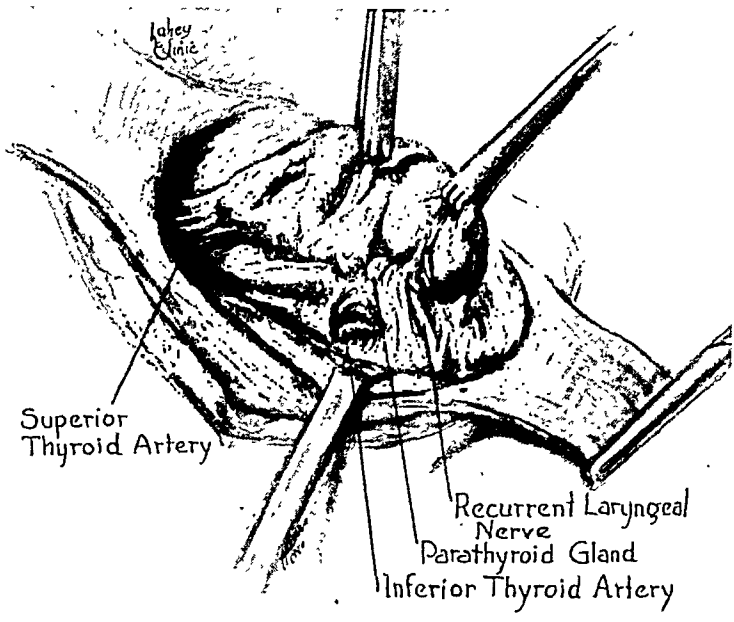


FIG. 2.—A drawing showing the thyroid lobe freed from the internal jugular vein; dislocated from its bed and held up so that it is suspended only by its attachment to the trachea. Note in it the recurrent laryngeal nerve, parathyroid gland, inferior and superior thyroid artery.

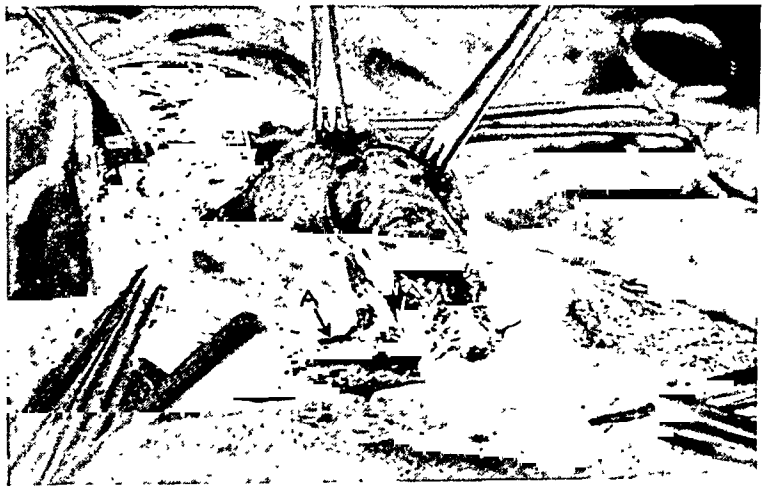


FIG. 3.—A photograph, taken at the operating table, to illustrate an actual picture of the method of mobilizing the gland and lifting it up out of its bed. Note in it the nerve marked (N), artery marked (A), and the superior thyroid artery marked with an arrow.

the superior, middle and inferior thyroid veins, detached from their point of entrance into the internal jugular vein; and the second, that the lobe of the thyroid is elevated from its bed and held up with double hooks (Figs. 2 and 3). With this exposure, and with the common carotid artery and

internal jugular vein dissected back from the thyroid gland down to the scalenus anticus, and with the superior thyroid artery, inferior thyroid artery, recurrent laryngeal nerve and parathyroids visualized, technical difficulties are, for practical purposes, completely avoidable (Figs. 2 and 3).

Hemorrhage during a thyroidectomy should never be in any way beyond the surgeon's complete control. The main blood supply to the thyroid is the superior thyroid artery and the inferior thyroid artery, both of which, if adequate exposure and anatomic dissection be accomplished, are visualized and can be ligated with safety. It has frequently been asked of us whether or not the ligation of both the superior and the inferior thyroid blood supply, on both sides, might not bring about tetany. Although we do not do it routinely, we have repeatedly ligated both the superior and inferior thyroid arteries on both sides, never with the production of tetany. No thyroid operation of any type, except possibly removal of a simple discrete adenoma, should ever be undertaken without the entire anatomy of the thyroid gland, including its superior and inferior arteries so completely visualized that should any excessive bleeding occur they can be immediately ligated and thus bleeding be entirely controlled.

It is unnecessary to discuss nerve injuries since we have written so extensively on the subject of visualization of the recurrent laryngeal nerves. One does well to remember, however, two or three warnings regarding this structure. The recurrent laryngeal nerve occasionally does not recur, but as stated in my article* on the subject, passes directly across from the vagus to enter directly beneath the inferior constrictor muscles. At times, this nerve descends a little further but not into the chest, and comes directly across from the vagus to hook under the inferior thyroid artery and then ascends to its position in the larynx. One must remember that the recurrent laryngeal nerve in its normal position not infrequently passes over the branches of the inferior thyroid artery or through the branches of the inferior thyroid artery, and if the lobe of the thyroid be mobilized from its bed and held upward as advised by us in these dissections it will be so pulled up that unless carefully demonstrated it can rather easily be injured (Fig. 4).

One of the most distressing complications of thyroid surgery is that of inadvertently making a hole in the trachea during the operation. Unless the correct procedure is undertaken, very properly, at this time, a serious outcome may result. If blood is sucked through the hole into the trachea, such an amount of coughing will result that the patient cannot be kept under the anesthetic; will struggle; come out of the anesthesia; become excited; suck in more blood, and eventually a fatality will result.

Should this complication arise there are two things to be done. A finger may immediately be placed over the opening into the trachea and held there until all bleeding is completely controlled and until the wound is absolutely

* Lahey, F. H.: Routine Dissection and Demonstration of the Recurrent Laryngeal Nerve in Subtotal Thyroidectomy. Surg., Gynec., and Obstet., 66, 775–777, April, 1938.

dry, at which time the finger can be removed and silk sutures inserted to close the opening. If an expert in the anesthesia of thyroidectomy is giving the anesthetic, and is immediately informed of this emergency, he can so increase the gas pressure in the trachea that air will constantly blow out and no blood go in, so that black silk sutures can be inserted to close the opening, with no blood able to enter the trachea. I know of no complication which can be more immediately serious than this, nor do I know of one which requires more prompt or more correct management.

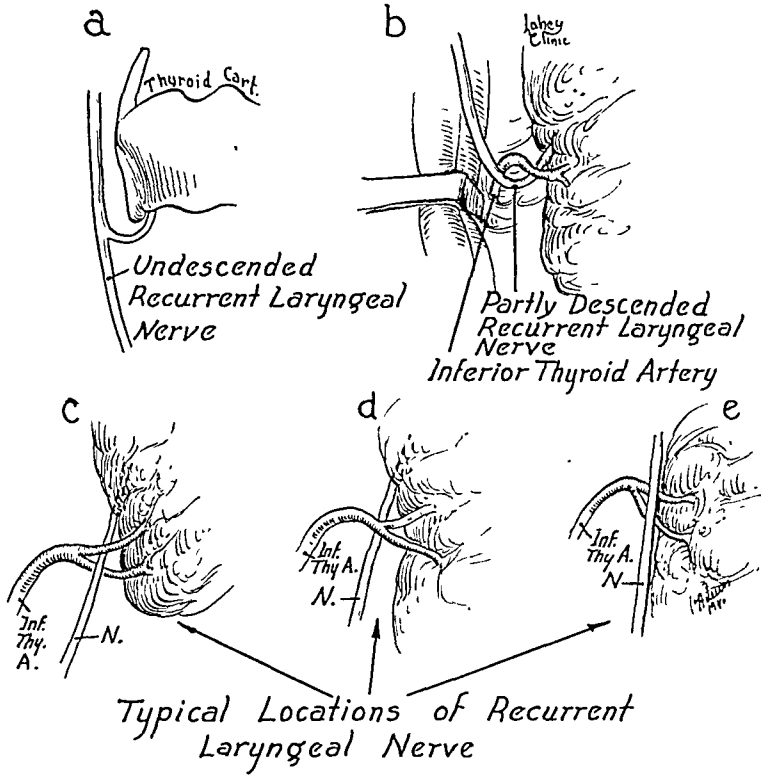


FIG. 4.—(a) Shows the unusual, but occasional, undescended inferior laryngeal nerve passing directly from the vagus to beneath the horn of the thyroid cartilage. (b) Partly descended nerve passing underneath the inferior thyroid artery but not descending into the chest and ascending to be inserted into the larynx. (c), (d) and (e) The three common locations of the recurrent laryngeal nerve in relation to the inferior thyroid artery.

Undoubtedly, many patients with thyroid disease are lost because of postoperative difficulties, among which is prolonged anoxemia. Everyone seems to hesitate or fear to perform postoperative tracheotomy in patients operated upon for thyroid disease. This is, in some measure, related to pride and, in some measure, to a fear of the production of pneumonia or, in deeper goiters, of mediastinitis. Most of these fears are groundless, and should there be any question whatever that a patient, postoperatively, is not receiving an adequate supply of oxygen, a tracheotomy should at once be performed. Those patients with a slight degree of cyanosis as a result of tracheal obstruction, who are permitted to go through the night suboxygenated and have a tracheotomy on the following morning, frequently continue to sink into un-

consciousness and coma, and die. Had these patients had a tracheotomy earlier, many of them, undoubtedly, would have been saved. When there is any question that patients with postoperative tracheal obstruction are not getting an adequate supply of oxygen, a temporary tracheotomy should be promptly established.

It is important that if these tracheotomies are to be but temporary and the tube removed within a few days, they be made at a proper level, and that is well down on the tracheal rings, below the level of the cricoid cartilage. At the level of the cricoid cartilage the trachea is the narrowest, and while this is the easiest point at which to perform a tracheotomy, it is the point, because it is the narrowest point of the trachea, at which stricture following removal of the tube is most likely to occur.

One of the most important points, in avoiding serious postoperative complications in thyroidectomy, is that in every patient upon whom a thyroidectomy is performed the trachea should be completely bared at the time of the operation. This is of value for two reasons: We have insisted that only by complete removal of the isthmus is it possible to remove adequate amounts of thyroid tissue; but just as important is the fact that by the removal of the isthmus the tracheal rings are so bared that should a tracheotomy become necessary postoperatively, valuable time will not be wasted removing the isthmus during the emergency, and an immediate tracheotomy can be performed quickly and easily (Figs. 5 and 6).

Postoperative hemorrhages after thyroidectomy are largely avoidable at the time of operation. Mass ligatures and gland suture in thyroid surgery have, in my opinion, no place in the control of thyroid bleeding. Vessels should be tied individually and accurately. One is apt to forget that the danger of a postoperative hemorrhage in patients, particularly with hyperthyroidism, is not so much the hemorrhage itself but rather related to the fact that they occur immediately after the operation or on the following day, at a time when the patient is in some considerable degree of postoperative thyroid reaction. If it becomes necessary to take this patient to the operating room or to give him an anesthetic or perform an operative procedure upon him for the control of hemorrhage during this stage of postoperative thyroid reaction, the already existing thyroid reaction may well be so intensified that it can throw the balance in the direction of a fatality, which was avoidable. When postoperative thyroid hemorrhages occur with any frequency, one cannot avoid the conclusion that they could have been avoided had more care been exercised in exposure and ligature of vessels.

One of the most distressing types of postoperative thyroid hemorrhage is when the ligature of the superior thyroid artery slips. The artery, being the first branch of the external carotid, bleeds profusely, and, producing, as it does, clots of blood high up under the muscle flap, is difficult to find and control. Attention to one point in ligature of this artery will prevent many of these hemorrhages. Never ligate the superior thyroid artery up under a skin flap with inadequate elevation of the skin flap and exposure of the

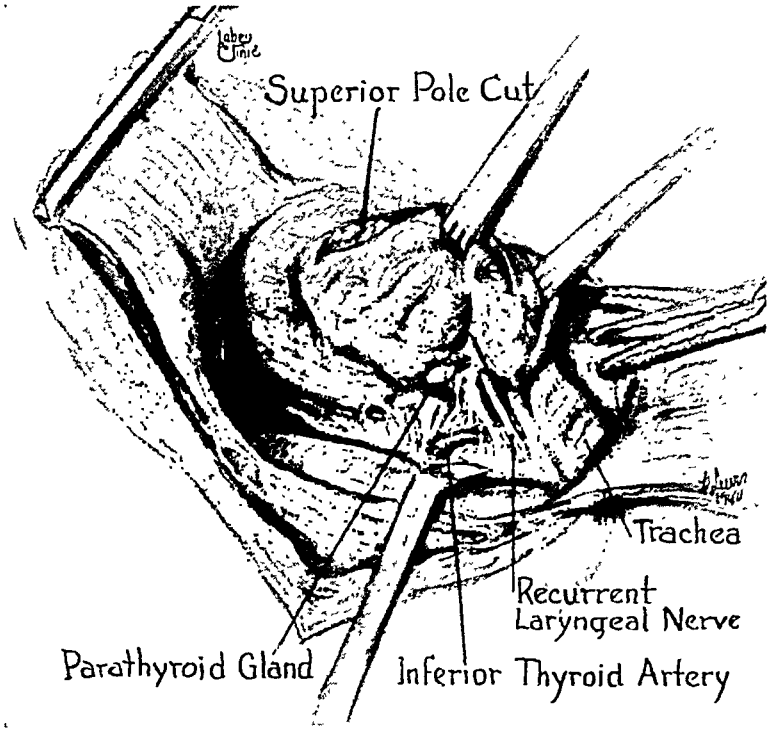


FIG. 5.—A drawing illustrating the detachment of the mobilized thyroid gland by severing the superior thyroid vessels, and by detaching the isthmus from the trachea so that the thyroid hangs only by the attachment of the body of the thyroid to the lateral wall of the trachea. By this mobilization and exposure the anatomic structures are visualized and the entire extent of the thyroid can be estimated so that radical and adequate percentages can be removed.



FIG. 6.—Actual photograph at operation. Note in this illustration, and in Figure 5, the bared trachea, the nerve, the artery, the severed superior pole, and the parathyroid gland.

vessel itself. So visualize the superior thyroid artery that it can be ligated as a trunk, well off the thyroid gland itself (Fig. 7). If the ligature is passed around the upper pole of the thyroid, as is so often the case, without this exposure it can include the tip of thyroid tissue into which the superior

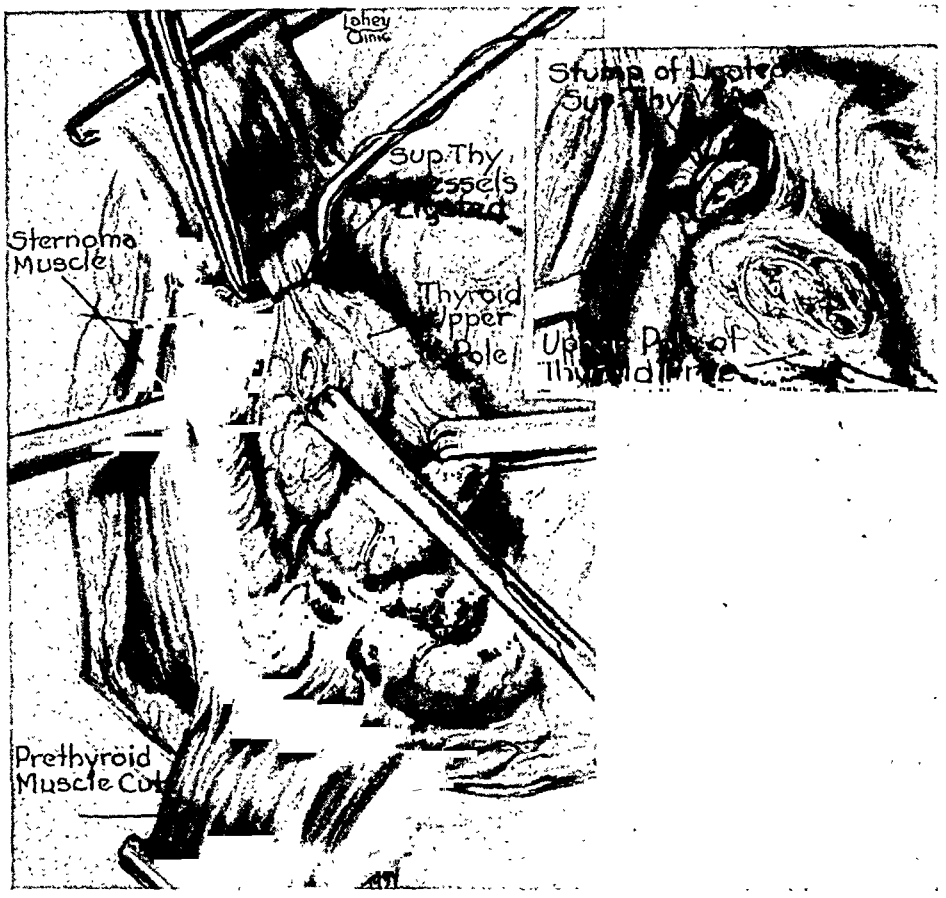


FIG. 7.—This illustrates the complete visualization of the superior thyroid artery and vein, and their ligature entirely off the thyroid gland. In the insert the remaining stump distal to the ligature is vessel and not thyroid tissue.

thyroid artery passes, which will interfere with adequate shutting down of the tie. This will often temporarily occlude the vessel, only to permit the tie to be coughed off with vomiting or with movements after the patient leaves the operating room and is returned to bed. Failure to observe this step has undoubtedly resulted in many serious postoperative hemorrhages from the superior thyroid artery. The same warning, likewise, applies to adequate exposure and ligature under direct vision when the inferior thyroid artery is tied.

There are two types of thyroid hemorrhage, one of which can bring about a very prompt and immediate fatality. The other is of but little importance. One, the latter, is that hemorrhage, occurring beneath the skin flap which bulges the skin flap out, is painful, and immediately obvious, but as a rule does not interfere with breathing because it makes but little pressure on the trachea. This can be cared for readily by elevation of the skin flap and control of the venous bleeding point. When, however, the bleeding is

from either a superior or inferior thyroid artery, beneath the prethyroid muscles, the accumulation of blood unable to escape from beneath the muscles exerts such pressure upon the trachea that complete tracheal obstruction can occur, resulting in prompt and immediate suffocation.

We have had four or five such experiences where patients' lives have been dramatically saved by having the neck wounds promptly pulled open, with no antiseptic precautions, by anyone at hand; immediate removal of the clot; and prompt and complete restoration of breathing. This is a real emergency in which immediate separation of the muscles and bailing out of the clot, with the introduction of a pack until the bleeding can be controlled, must be instituted at once. Failure to do this, undoubtedly, will and has resulted in many fatalities.

After this large experience with thyroid surgery, if I were asked to state what, in my opinion, exclusive of a fatality, was the most undesirable operative complication in a patient operated on for thyroid disease, I would unhesitatingly say *tetany*. While the administration of calcium chloride, parathormone and dihydrotachysterol (A.T. 10) now controls tetany quite well, there are cases which do not respond satisfactorily to the employment of these measures. Their cost is not inconsiderable, and the symptoms of tetany, when they occur, are not only distressing but incapacitating. The apprehension associated with their possible occurrence is very disturbing to any individual in whom this complication has occurred. When we are able to report that in this entire series of thyroid operations there have been but ten cases of established tetany and that tetany has not occurred in the last 4,000 thyroid operations, it will be obvious that the complication is avoidable.

If certain procedures which we have definitely established are followed, the occurrence of tetany following thyroid operations should be almost completely eliminated. The factors controlling the preservation of the parathyroid glands are related to the employment of a few simple rules. The location of the parathyroid glands is not infrequently atypical, but in the majority of cases they can be demonstrated if one obtains an adequate exposure, with the prethyroid muscles cut. Why there should be such sentimental discussions as to whether or not the prethyroid muscles should be cut, I have never been able to understand. We have cut literally thousands of prethyroid muscles, we have observed the end-results over a long period of time, and if they are cut high, well up under the skin flap and above the point where the innervation enters the gland, there will be no disfigurement and little, if any, added discomfort. In our hands, at least, it is not possible to obtain as adequate exposures of the region of the recurrent laryngeal nerves and the parathyroid glands with the muscles uncut as can be obtained with them cut. The advantages of not cutting the muscle are, in my opinion, trivial compared with the benefits and safety resulting from the more adequate exposure which can be obtained with the muscles cut across.

The most important thing in preserving parathyroid glands is that the

thyroid gland, as shown in Figure 2, be completely detached from its venous attachment to the internal jugular; picked up with double hooks, inserted in its outer border; pulled out of its bed and so lifted that it hangs by its attachments to the trachea, thus exposing the posterior aspect of the gland where, with a dry field and a good light, the region of the parathyroids may be clearly demonstrated, adequately inspected, and these structures dependably preserved. It will be impossible to be certain of preserving parathyroid glands unless thyroid operative fields are absolutely dry. In the presence of pools of blood and oozing vessels, parathyroids will go unrecognized and, of necessity, occasionally be unnecessarily removed. Too many thyroid operations are undertaken with the assumption that thyroid surgery must be performed in the presence of a large amount of venous and arterial bleeding. In addition to the above suggestions, the ordinary amount of illumination of an operative field will be inadequate for satisfactory demonstration of anatomic structures as minute as are those involved in thyroid surgery—parathyroids and recurrent laryngeal nerves. In further addition to this, there will be times at which, even with these requirements fulfilled, uncertainty will still exist as to the identity of certain gland-like structures suspected of being parathyroids. Under such conditions the Berens-Beebe loupe magnifying glasses, as previously suggested by me, will usually demonstrate whether or not the uncertain structures are parathyroids.

Another undesirable complication of thyroid surgery, particularly surgery for hyperthyroidism, is the removal of too much or too little thyroid tissue. I have written on this subject, giving indications for radical removal and for less radical removal in relation to how well a gland involutes under iodine, and the relation of blood iodine to the necessity of radical removals of thyroid tissue. As has been stated in the prevention of tetany, no plan which deals with percentage removal of the thyroid gland and percentage preservation of the thyroid remnant can hope to be effectual unless similar warnings as those stated in connection with the prevention of tetany are recognized. Most cases of recurrent hyperthyroidism are the result of attempting subtotal thyroidectomy without adequate exposure and adequate mobilization of the thyroid gland, and without adequate demonstration of the anatomic structures, such as the recurrent laryngeal nerve and parathyroid glands. When one knows where the recurrent laryngeal nerves and parathyroids are and can see them all the time, radical removals of thyroid tissue can be undertaken. When this is not true, the tendency will be to leave too thick remnants of thyroid tissue behind to protect them from injury. In Figure 2 will be seen the operative maneuver by which the thyroid gland, with the prethyroid muscles cut, is detached from its venous connection with the internal jugular vein, mobilized from its bed between the great vessels, the trachea and the esophagus, and lifted up, with its recurrent laryngeal nerve so demonstrated that it can be proven to be in its normal position, and so demonstrated that one can, with safety, ligate the vascular attachment to the inferior pole and the isthmus of the gland, and that structure turned up from

the trachea. The superior thyroid artery and vein can be ligated, and the upper pole so turned down that the thyroid gland is attached only at its body to the side of the trachea and at the point where the inferior thyroid artery enters the gland and the parathyroids are attached to the gland. In addition to this, the isthmus can be so detached from the trachea and the opposite lobe that only that body portion of the thyroid which is attached to the lateral wall of the trachea is left behind. In our experience, when this method of detaching the thyroid gland from the isthmus and from its upper

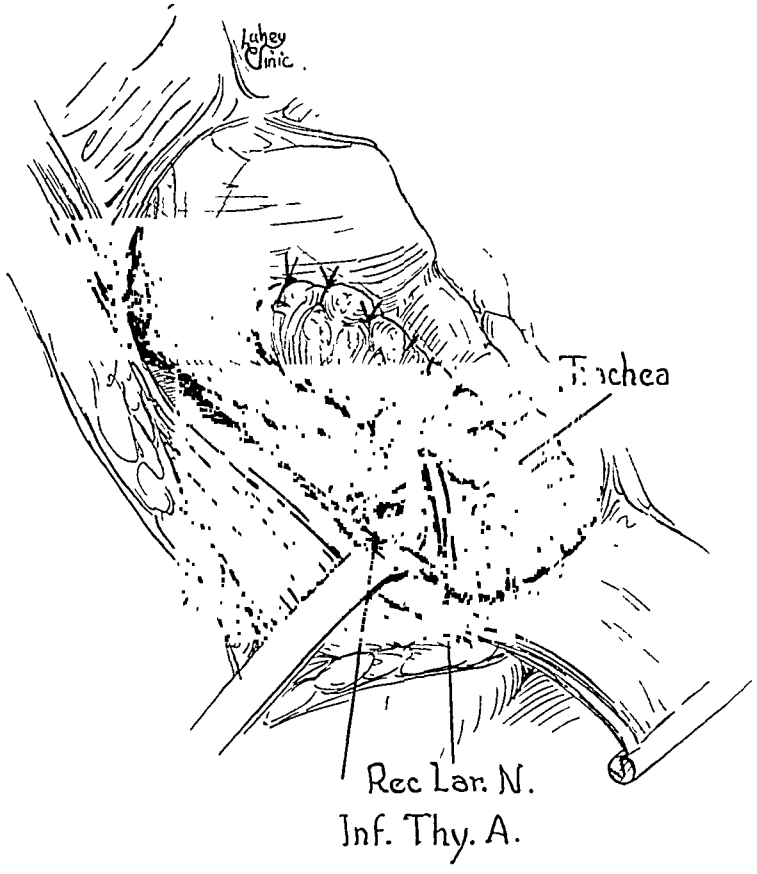


FIG. 8.—A drawing illustrating the method of suturing the remnant of thyroid against the trachea to control oozing, by which it is possible to almost entirely eliminate drainage in subtotal thyroidectomy for exophthalmic goiter.

and lower attachments to the trachea is employed, adequate removal of thyroid tissue with preservation of the recurrent laryngeal nerves and the parathyroids can be accomplished. This has been, in our experience, the safest and most reliable method of removing a sufficient amount of thyroid tissues without damage to other structures (Fig. 6).

The method of suturing the thyroid remnants against the trachea, shown in Figure 8, has also eliminated one of the unnecessary and undesirable postoperative complications, and that is drainage. Almost no patient operated upon for hyperthyroidism during the last several years, in our experience, has required postoperative drainage.

FIG. 9.—(a) Showing an incision resulting in a scar which is placed so high that it cannot be successfully concealed. (b) An incision which has been made too straight and with inadequate curve, so that it does not fall into the folds between the neck and the chest. (c) An incision too much of the horseshoe type, which, likewise, does not permit of concealment. (d) A symmetrical curve placed at the proper level where the neck joins the chest. In addition to this is illustrated in its central portion an undesirable complication of keloid formation, difficult to avoid in certain skins. (e) An improperly placed incision over a very large and prominent goiter. The scar has slipped down over the front of the chest to a position where it cannot be concealed. Had compensatory elevation of the incision been made, it would have descended to its proper level in the grove between the neck and the chest.

It is interesting to observe that one may have operated upon a woman for an hyperthyroidism so severe that she is practically incapacitated, may accomplish slowing of the pulse to normal, elimination of all undesirable nervous symptoms, and restoration of weight to a normal level, yet when this patient is seen with this striking change at the end of a year she will not infrequently fail to remark upon her physical improvement but state her pleasure in the postoperative results in the terms of the beauty of the scar. If the scar be unsatisfactory, she may utterly fail to express appreciation of the physical improvement, and complain bitterly of the appearance of the scar. It is for this reason that postoperative thyroid scars are of such importance, situated as they are in a region constantly exposed, and since nine out of ten thyroid operations, in our experience, are performed upon women, with these facts in mind, it is obvious that an unsightly thyroid scar is an important postoperative thyroid complication.

The location of the scar is of extreme importance. Many unsightly scars are placed too high, where they are constantly visible and cannot be concealed by beads (Fig. 9 a). The mistake of placing them too low is made much less often than placing them too high. Many unsightly thyroid scars are unbalanced, one side being higher than the other. Another bad feature of thyroid scars is that they are not infrequently made too straight rather than curved, which prevents them from disappearing largely in the fold between the neck and its attachments to the chest (Fig. 9 b). Another unsightly thyroid scar, as these cases come to us, is the horse-shoe type, in which the lateral limbs run too far up over the side of the neck (Fig. 9 c). It is important that thyroid scars be symmetrically curved as shown in Figure 9 d, so that they fit and, at least partially disappear in the fold at the junction of the neck and chest.

A common mistake which is made in thyroid incisions, as we have repeatedly stressed in discussing this subject, is that with prominently projecting goiters an incision is placed at the proper level at the time of operation, but when this tumor has been removed, because of the slipping of the loose and prominent skin of the neck, it descends to an unsightly position on the front of the chest where it cannot be concealed. In the same way, when the prominence of the neck from a one-sided goiter is unilateral, due to the fact that on one side there will be skin slippage greater than on the other, a scar which at the time of operation is well placed, will tilt on one side in an unsightly manner (Fig. 9 e). These are but a few of the undesirable complications in relation to scars which occur following thyroid surgery, most of which can be avoided by attention to a few simple details.

SUMMARY

An attempt has been made to discuss and illustrate some of the serious, undesirable and largely avoidable complications associated with partial thyroidectomy. The measures developed in a large experience with the operation are likewise discussed, described and illustrated.

DISCUSSION.—DR. GEORGE M. CURTIS (Columbus, Ohio): At my first appearance before this Association, may I express my appreciation of the privilege of becoming a Fellow. It has been a pleasure to hear these two papers concerning thyroid disease. The unquestioned experience of the one and the insight of the other speaker have resulted in a profitable clinical review.

One question, however, arises, and I would like to make one suggestion. The question concerns the mechanism of the beneficial effect obtained after ligating the superior thyroid arteries. We have employed this procedure, as have so many, and undoubtedly benefit at times comes from it. On the other hand, after studying the collateral arterial supply to the thyroid gland, it became evident that the blood supply is but little affected by the usual ligature. Moreover, the thyroid gland receives its principal blood supply from the inferior thyroid arteries rather than from the superior. Too, the collateral interconnection between the superior thyroid arteries and the arteries of the larynx, pharynx, trachea and esophagus is most extensive. It would, consequently, appear that the beneficial effect is not particularly due to a diminution of the greatly increased blood supply. Rather, it would seem more reasonable to regard the good results as due to ligature of the accompanying nerves. It would be interesting to hear further discussion concerning this matter.

Perhaps the most severe immediate postoperative complication is the thyroid "crisis" or "storm." Prevention of this is, thus, the more important, and is mainly brought about by adequate preoperative management. Since prevention has become so significant, every effort should be made to accomplish it.

Patients with hyperthyroidism do not hold iodine. Careful balance studies reveal that they progressively deplete themselves of iodine. Moreover, when iodine is administered, it is first stored, but eventually hyperthyroid patients lose the amount which is stored, and even more, after the administration is stopped. In similar manner, it is not so generally known that patients with hyperthyroidism, likewise, deplete themselves of calcium. Careful studies of this matter were originally made by Aub and his associates. More recently we have confirmed these studies and have also added the beneficial effect of thyroidectomy.

We find patients with advanced exophthalmic goiter greatly depleted of calcium owing to a greatly increased negative calcium balance, which may be even greater than that of patients with hyperparathyroidism. Because of these findings, some time ago we began to give our patients calcium preoperatively, as well as iodine.

It has been shown that vitamin D increases the permeability of the intestine to calcium. Therefore, we used high vitamin D along with the calcium. We found, subsequent to instituting this principle of replacement therapy, that our postoperative reactions were less severe. Moreover, we have not had one real "storm" since calcium replacement was also added to the usual preoperative therapy.

On the other hand, all-around careful preoperative preparation, as has been outlined, is paramount. It is difficult to conclude that administration of calcium and vitamin D is any single outstanding factor, nevertheless the rationale of this replacement is evident and we consequently give it. Calcium may be readily given as milk. Calcium lactate is best given in solution. The mechanism whereby calcium replacement is of particular value is not yet clear. An adequate subtotal thyroidectomy, however, abruptly halts the depletion of calcium storage.

DR. ROBERT S. DINSMORE (Cleveland, Ohio): Last year I had the pleasure of dedicating an article on this same subject in Doctor Lahey's birthday book. There are two minor points which might be mentioned in the preparation of these cases, which I think are danger signals. These are the presence of a recent delirium, or a pulse curve which will not come down. After all, the question of technic is more or less an individual problem. A satisfactory technic is one which, in a properly prepared patient, can be done with a minimum of anesthesia; in a reasonable length of time; with the removal of the proper amount of thyroid tissue; protection of the recurrent laryngeal nerve and parathyroids; a resultant satisfactory scar; and, above all, the cure of the patient.

The question of exposure of the nerve is again an individual problem. Personally I do not do it. Doctor Lahey wants to see where it is, and I want to see where it is not; in other words, he wants to see it every day and I never want to see it. In this connection, there is one thing which might be mentioned; I have had men ask me to show them the nerve, as Doctor Lahey does. As you have seen from his illustration, he only exposes it at its vital points, but many surgeons have the impression that Doctor Lahey exposes it in its entirety, which is not correct.

There is one distressing complication which I wish to mention, that is, postoperative psychosis. A differentiation should always be made between true toxic delirium of hyperthyroidism and a major psychosis. You are dealing with two diseases if a psychosis develops; in other words, you have a psychosis and hyperthyroidism, and if one of your patients develops this complication, you can tell the family that the psychosis is a separate disease and has nothing to do with the hyperthyroidism. In every such instance we have had, a psychiatrist has been able to elicit a previous history of psychosis in that individual. Sometimes you are blamed because these patients may have to go to a sanitarium. The last such patient I had has been in a sanitarium for a long time with dementia praecox, and peculiarly enough, two of her neighbors came in with simple goiters and asked that they be taken out before they too went crazy.

To return for a moment to the question of nerve injuries—sometimes nerves are injured in most unexpected ways. I was always under the impression that it was almost impossible to have a recurrent laryngeal nerve injury when an intrathoracic goiter was extruding itself from the thorax. However, I once had a very delightful old doctor with an intrathoracic goiter, and he was particularly anxious about his voice, as he sang bass in a choir. After the upper pole was freed, he literally coughed the right lobe out of his chest, and, at this time, he had a voice change which proved to be a recurrent laryngeal nerve injury which has never recovered. This was an instance, in the absence of instrumentation, in which I actually saw the change take place.

DR. ROBERT W. BARTLETT (St. Louis, Mo.): A surgeon's success in the treatment of toxic goiter is measured largely by his ability to estimate accurately, preoperatively, the risk in any given case. In order to do this he must follow certain criteria of operability which, in his hands, have proved the most reliable indicators of the proper time for operation and the amount of surgery to be undertaken at that time.

I have recently completed a 15-year mortality study for toxic goiter in our private practice. The total number of thyroidectomies in this series approximates 1,500. I am presenting several slides which bring out facts learned from this study, which may prove of interest.

This series, naturally, divides itself into two groups because in the first place there are about 700 cases in each and, secondly, because as a result of an earlier mortality study of the 1926–1930 group we formed our present "criteria of operability" which were applied to the second group extending from 1931–1940, with the result that we were able to cut our mortality practically in half, namely, to 1.7 per cent for the second period.

As indicated in the second illustration, we defer operation in the presence of cardiac decompensation, or if the patient is losing weight as rapidly as a half-pound a day, or if the patient is either in or has very recently been in a thyrotoxic psychosis. Likewise, operation is delayed and the medical regimen continued if the patient is vomiting; is still sweating; is having a diarrhea or if, upon repeated basal metabolic determinations, the rate is rising rather than falling. If such is the case, she is obviously in the nonsurgical phase of the cycle. Our last and most important criterion of operability is the breath-holding test, reported by my brother, Doctor Bartlett, Jr., about ten years ago. From extensive use of this test we are now able, with considerable accuracy, to determine not only whether the patient can stand an operation but also how much surgery she will tolerate without undue risk.

In the third illustration it is seen that in the first period several patients died following the second stage of two-stage procedure, whereas in the second period there was no death following a second lobectomy. This is explained by the fact that we set up the rule for ourselves, as a result of the first mortality study, that a patient must be measurably as good a risk for the second-stage as she was for the first-stage lobectomy and, if such is the case, the patient will obviously always survive the removal of the second side. I wish, also, to call to your attention that we have not performed an upper pole ligation since 1931, feeling that this procedure has very little therapeutic value and often carries a very considerable hazard for the type of patient who was previously considered sick enough to require preliminary ligation. It is our belief that the improvement obtained in some cases following ligation is due principally to the several weeks or months of additional medical management which follows the ligation but precedes the thyroidectomy, rather than to the ligation itself.

As will be noted in the last illustration, 70 per cent of the deaths in the first period were associated with crisis, while in the second period only 25 per cent (three deaths) were due to postoperative crises, which indicates quite clearly that patients are now being estimated with a high degree of accuracy preoperatively. The remaining nine deaths in the second period are largely accidental in nature and are common to any type of surgery, whether it be cholecystectomy, herniorrhaphy or thyroidectomy. We will probably never be able to avoid such incidents as pulmonary embolism, cerebral accidents, and occasional drug poisonings. Finally, I would like to point out that, since 1935, we have not only not had a death in crisis but have not had a really severe postoperative storm.

DR. HAROLD L. FOSS (Danville, Pa.): As one listens to these discussions on how to handle patients with hyperthyroidism who are especially serious risks, and reads the literature dealing with the question, one is more and more impressed by the fact that there are many ways of accomplishing the same thing and doing it well. Doctor Lahey performs a high percentage of multiple-stage operations, while Richter of Chicago performs none. I am constantly resorting to stage-operations, while John Pemberton almost never utilizes the method, and so there you are!

However, the man whose mortality runs much over 4 or 5 per cent, and

who performs all his operations single-stage, is overlooking a valuable procedure. No one can question the value of ligations in selected cases in which it is clearly indicated. Improvement will be strikingly apparent in 90 per cent of the patients so treated. This whole subject was completely discussed in a paper a few years ago by Lahey and Schwalm. Some never ligate or even perform a multi-stage operation, and seem proud of it, and frequently emphasize it in discussions and in their literary contributions. They even refer to the folly of such a timorous policy and, as a remarkable thing, they seem to have a respectably low mortality record. The next group, whose mortality figures are expressed to the right of the decimal point, perform many ligations, and with their serious risk patients always resort to multi-stage operations. I stand, however, with the latter group, thoroughly agreeing with them as to the advisability, even the imperative necessity, of stage-operations in the serious risk patient with advanced hyperthyroidism.

DR. FRANK H. LAHEY (Boston, Mass., closing): Papers on thyroid disease always promote discussion. I have never heard thyroid disease discussed without its taking up a considerable period of time. Perhaps this is because it is such a satisfactory field, and also because so much progress has been made in it that it is a tribute to surgery in general. With the mortality statistics from all over the country being about the same, and when one considers what the mortality rate used to be, one may really say that it indicates definite accomplishment.

I am sure that the universal employment of one-stage operations, as advocated by some, is a dangerous plan. Thyroids are not the same, in my opinion, the world over. Thyroids in the Middle West are often, I believe, quite different from thyroids along the Atlantic seaboard. For instance, we do not live in a region where goiter is endemic, and so, practically half of our goiters are exophthalmic, and a quarter, toxic adenomata. Therefore, three-fourths of the goiters we see are toxic goiters. One must remember how different this is from Kocher's experience. When Kocher died, he had operated upon 5,000 goiters, but only about 250 exophthalmic goiters. In addition to that, realize that most of the thyroid clinics in regions where goiter is endemic, are diminishing, probably due to the fact that the employment of iodine is diminishing the number of adenomatous goiters in which toxicity can develop; while in our clinic, I am sure not due to the increasing popularity, the number of thyroids operated upon is remaining about the same.

It is important, therefore, that you do not take for gospel that you can perform 100 per cent one-stage operations on all cases. It is essential, as I have stated in the paper, that you reach a decision regarding multiple-stage operations upon your own experience and not that of others in other parts of the country. In addition to that, if you are going to make the mistake of trying to save patients time and money, be sure you have them around afterward so that they can enjoy it.

There is another kind of mistake which is made and that is in a borderline case. Do not operate upon a borderline case to prove whether or not it is a case of hyperthyroidism. If you will let the case alone it will be proven by time. Most patients will give you a clinical demonstration with time as to whether or not they have hyperthyroidism. No patient who is a borderline case is going to die, because his disease, if it is hyperthyroidism, is not that intense. If you give him time he will so demonstrate hyperthyroidism, if he has it, that you can make a clinical diagnosis without difficulty, and if he does not, in all probability he does not have it.

As relates to warnings about operating upon people with decompensation,

one should recall that the thyrocardiacs, which I have stressed in the literature, are those cases which show decompensation that persists or remains stationary, in which patients cannot be made to regain their cardiac capacity. These patients often have general anasarca, ascites and even bloody sputum. These patients, I think, in spite of their decompensation, are the ones in which such brilliant results can be obtained, and not with a high mortality rate—3.6 per cent in our experience.

Another warning to stress is that while a high metabolic rate does indicate toxicity, a low rate by no means indicates safety. An additional warning we have repeatedly stressed concerns the blood iodine level. This is an expensive determination, but if one is able to do it, it is of value to realize that the low blood iodine levels in patients with hyperthyroidism do represent the bad risk cases and those in which recurrence is apt to take place.

DR. WARREN H. COLE (Chicago, closing): I want to thank the discussers, particularly Doctor Curtis, for mentioning the question of calcium deficiency. This is relatively new, and I think we should be well aware of it and utilize calcium in our therapy. It may be extremely important in judging operability. The use of vitamins B, C and D might also be helpful.

I wish to emphasize, again, the necessity of establishing some sort of prerequisite in determining operability. This certainly will clarify operability and every now and then eliminate a postoperative death.

PRECAUTIONS IN THE TREATMENT OF THYROTOXICOSIS*

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IT IS USUALLY UNWISE to resort to the utilization of fixed rules in the treatment of a disease. However, on the basis of clinical experience, and since the toxicity in thyrotoxicosis can be measured so definitely by clinical and laboratory means, it appears that this disease may be an exception. Some of the precautions to be utilized are so concrete that they can actually be placed on a mathematical basis.

Diagnosis.—It is not the purpose of this presentation to discuss the manifestations, but the necessity of making an accurate diagnosis must be emphasized. The frank and typical case of thyrotoxicosis can be diagnosed readily. The mildly toxic cases, however, may be simulated by numerous diseases including pulmonary tuberculosis, leukemia, endocarditis, neurocirculatory asthenia, *etc.* When the diagnosis is doubtful the patient should be examined thoroughly with the idea of eliminating such diseases. The seriousness of performing a thyroidectomy, when the manifestations are really produced by one of these other diseases, need not be emphasized. Perhaps the condition most apt to be confused with mild hyperthyroidism, is neurocirculatory asthenia. In this disease the nervousness, tachycardia, loss of weight, weakness, sweating, *etc.*, may be identical with that encountered in thyrotoxicosis. There will not be enlargement of the thyroid; a point, however, which does not eliminate entirely the possibility of thyroid disease. If other features fail to differentiate the two diseases, very reliable information can be obtained by noting the response to iodine. If the patient is put on routine Lugol's therapy and does not respond as do patients with hyperthyroidism, the diagnosis of neurocirculatory asthenia will be more likely. Another disease readily confused with early hyperthyroidism is hypertension, because manifestations including tachycardia, hypertensive palpitation, "nervousness," elevated basal metabolic rate, *etc.*, as has been emphasized recently by Crile and McCullagh,[1] are common to both diseases. However, it should be remembered that the two diseases may be present simultaneously; Bisgard[2] noted that in a series of 265 cases of thyrotoxicosis, essential hypertension was present in 8 per cent of the cases. The degree of toxicity in patients with a doubtful diagnosis is always mild. Little or no harm can, therefore, result from delay in radical treatment; with observations during this period of delay, the diagnosis will, with very few exceptions, become established.

Preoperative Treatment.—If the diagnosis of thyrotoxicosis is made,

* Presented at the Fifty-third Annual Session of the Southern Surgical Association, Hot Springs, Va., December 11, 1940.

a decision must be made as to the type of therapy to employ. Obviously, it may be medical or surgical. Nevertheless, as years go by, with such favorable results reported following surgical treatment, fewer reports on medical treatment are encountered in the literature. In medical treatment, roentgenotherapy is an important feature. It seems to be the consensus of opinion, however, that although roentgenotherapy will frequently result in marked improvement of symptoms for a period of time, it is rarely curative. It is true, however, that there is a small group of patients with the diagnosis of mild hyperthyroidism, presumably accurately made, who need not be subjected to thyroidectomy. I have in mind particularly a group of young people, who have accepted, or had thrust upon them, an unusual amount of activity or worry, and have developed symptoms of hyperthyroidism incident to this sudden change in their routine way of living. Not infrequently, removal of the source of mental and physical strain, with an increase in the amount of rest and sleep will result in a cure without thyroidectomy.

The following measures should be adopted in principle in the treatment of all cases of hyperthyroidism, but apply particularly to those with moderately severe toxicity:

(1) *Administration of Iodine.*—The advantages of iodine administration, particularly in preparation of the patient for thyroidectomy cannot be disputed. Ordinarily it is given in the form of Lugol's solution 5 to 15 M. three times a day. In mild cases, the patient may, and should be treated in an ambulatory fashion; hospitalization should be reserved for severely toxic patients, as will be discussed later. Although the maximum benefit appears in 10 to 12 days, it is commonly preferable, particularly in the severely toxic group to continue therapy several days longer before operation. Patients who have had prolonged treatment of iodine are frequently problems in therapy. The author agrees with Lahey,[3] that in patients who are severely toxic, not ready for operation, it is preferable with few exceptions to maintain hospitalization awaiting remission, rather than to discontinue Lugol's solution and send them home. In a study of results following therapy with lugolization over a varying length time, Lehman and Shearburn[4] were unable to find much relationship of the duration of iodine therapy (beyond the period of maximum benefit) to results.

(2) *Control of Physical Activity.*—Patients under treatment for thyrotoxicosis should stop working, particularly if physical exertion is required. Mild activity, requiring little exertion, and serving to occupy the patient's mind for a few hours during the day is acceptable and frequently advisable. Patients with a mild or moderate degree of toxicity should not be confined to bed during the period of preoperative preparation with iodine because of the constant weakness produced by it; they may, in fact, be treated as ambulatory patients, keeping them in the hospital for two or three days before operation to accurately establish their degree of toxicity. Bed rest in the hospital is reserved for patients with severe toxicity or those with cardiac decompensation.

(3) *Elimination of Worry and Psychic Trauma.*—It is exceedingly important in patients with severe toxicity that they be removed from an atmosphere creating emotional disturbance. They should be segregated from illness in the family, financial worries and other family troubles as much as possible. Moreover, severely toxic patients should not be informed as to the date of operation. They may be told that an operation will be necessary at some future date but a responsible relative should be informed as to the exact date of operation.

(4) *Sedation.*—Since sleeplessness is one of the cardinal symptoms of hyperthyroidism, sedatives are definitely indicated. Barbiturates (*e.g.*, phenobarbital in a dose of ½ gr. two or three times daily) are the most popular. Daniels[5] has expressed the opinion that they actually have an antagonizing effect upon the action of the thyroid on the brain; but this point is not proven. However, barbiturates depress the basal metabolic rate of animals and human beings, whereas morphine is not as effective in this respect.

(5) *Increased Food Intake.*—It is extremely essential that the caloric intake be raised to the point where a *weight gain* is registered. Naturally, the amount of food required for this will depend, to a great extent, on the degree of toxicity. Not infrequently an intake of less than 5,000 calories will not be sufficient to bring about a gain in weight. This represents a large intake; but since an increased appetite is a manifestation of hyperthyroidism, these patients are usually able to take that amount. Part of this quantity will have to be ingested between meals and at bed-time, in the form of light food. Theoretically, the diet should not be very high in proteins, on account of the specific dynamic action of proteins. However, the author agrees with Womack[6] that the good effects resulting from a large amount of protein in the diet more than neutralize the increased metabolism resulting from the specific dynamic action. Naturally, adequate fluids must be maintained. Of the vitamins beneficial in hyperthyroidism, A and B_1 are perhaps most important. Their beneficial action is probably dependent upon the increased needs incident to the elevation of the basal metabolic rate. For the most part, it is probable that a properly balanced diet in the large quantities mentioned above would contain adequate vitamins.

(6) *Treatment of Complicating Diseases.*—Thyrotoxicosis is not infrequently associated with diabetes. In spite of the fact that the presence of diabetes would increase the mortality rate to some extent, the indications for thyroidectomy are about as great as in a patient with uncomplicated hyperthyroidism. It appears to be the consensus of opinion that thyroidectomy for toxic goiter in the presence of diabetes markedly improves the carbohydrate metabolism. It should be emphasized, however, that thyroidectomy should not be performed until the degree of diabetes and the amount of insulin required are firmly established. Cardiac decompensation is frequently encountered in thyrotoxicosis (particularly the type associated with nodular goiter), and, in reality, is a strong indication for thyroidectomy with removal of most, if not all of the thyroid on each side. However, operation should

not be performed while the patient has acute decompensation with edema and ascites. With adequate rest and medical care, including the use of digitalis, salyrgan, *etc.*, the patient will be brought around within a week or two to a condition considered as a fair operative risk.

Miscellaneous Therapy.—In view of the recent observations of Curtis, and associates,[7] in which they showed that a definite negative calcium balance exists in hyperthyroidism (particularly the toxic diffuse type), calcium therapy would appear indicated. Patients with severe hyperthyroidism should be given intravenous glucose preoperatively on the morning of operation.

Prerequisites for Operation.—It is probable that each surgeon has a set of prerequisites of his own, which he utilizes in determining operability in thyrotoxicosis. Although there may be individual variations, the principles will be identical. Some of these prerequisites are so definitely understood, and agreed upon, that they can actually be listed on a mathematical basis. It should be emphasized, however, that each patient, in the long run, must be looked upon as an individual problem, and all features analyzed before arriving at important decisions regarding operation, *etc.* The prerequisites (i.e. for bilateral thyroidectomy), as utilized in this clinic, may be listed as follows:

(1) *Gain in Weight* is, unquestionably, the most important prerequisite for operation in patients with severe thyrotoxicosis. Under no circumstances should a patient with a significant degree of toxicity *be subjected to operation without observations on the weight* of the patient demonstrating a definite gain. As stated previously, the amount of food may have to be increased to an intake of 5,000 calories before a satisfactory gain in weight can be produced. Rarely, indeed, will the thyroid patient fail to gain if the caloric intake is adequate. If he is quite toxic and fails to gain, operation must be postponed until the various procedures in conservative treatment, including perhaps roentgenotherapy, have been utilized. In patients who have lost considerable weight, a simple gain in weight itself will not be sufficient. It can be stated, definitely, that these patients should have regained a major part of their loss, which may amount to 30–35 pounds. Unquestionably, the danger of ill effects from prolonged iodine medication will be more than neutralized by the improvement in the patient's physical condition incident to a marked gain in weight.

(2) *The Resting Pulse Rate Should Be Below 110.*—Obviously, temporary exertion and emotional strain will increase this rate. If a moderate amount of mental or physical activity elevates the pulse rate very far above this level, this one factor may be an important indication that the optimum physical condition has not been attained. Obviously, the pulse rate will not be of value in patients who have auricular fibrillation. So often, however, in patients who have cardiac damage of that degree, the amount of thyrotoxicosis is mild, therefore, allowing one to utilize the state of cardiac compensation as the important factor in determining operability.

(3) *The Basal Metabolic Rate Should Be Less Than 50 Per Cent Above Normal.*—Naturally, this prerequisite is somewhat empiric, particularly, because the basal metabolic rate is frequently inaccurate, not actually depicting the degree of toxicity. However, it can be safely said that patients with a metabolic rate much above 50 at the time of operation are apt to have a stormy postoperative course.

(4) *Administration of Iodine* should extend over a period of at least two weeks, particularly in the group of patients whose toxicity is above average. Although the so-called optimum level may appear to be reached a few days earlier, the author is convinced that operability will frequently be markedly improved by delay.

(5) *Improvement in Symptoms* must take place following iodine administration and other therapeutic measures. Improvement in symptoms is, to a great extent, an index of favorable reaction to lugolization. If the thyroid gland has failed to absorb iodine, with consequent amelioration of symptoms, postoperative reactions will commonly be encountered. Moreover, in patients whose diagnosis is uncertain, the failure of response to iodine may indicate, strongly, that the diagnosis of thyrotoxicosis is incorrect.

Rarely will it be justified to break the above rules. There will be occasions, however, when patients will be so toxic and will respond so poorly that they cannot be brought down to a level which meets these requirements. Occasionally we have noted that all of these five prerequisites cannot be met. In this case, if the other four prerequisites are met, with a reasonable margin of safety, we assume that the one out of line will have been neutralized. We are very reluctant, however, to undertake operation if more than one of these prerequisites cannot be met. Obviously in these doubtful cases the question of excision of only one lobe will arise. This problem is discussed later.

The decision as to *time of operation*, therefore, becomes one of the most important problems in the treatment of severe thyrotoxicosis. It is a safe axiom to always postpone operation when there is doubt as to operability, since, with prolonged care remissions are bound to take place and operability, therefore, will be improved. Naturally, when severe cardiac damage is being inflicted by the thyrotoxicosis, delay will be detrimental to the heart. However, as stated previously, in these patients with severe cardiac symptoms the toxicity is usually diminished to a point where the question of operability is determined by the state of cardiac compensation. When severe toxicity exists, there should be no hesitancy in sending patients back to the ward from the operating room, if it appears that they have not reacted properly to the psychic shock of preparation for operation. For example, if a tachycardia of 130 or 140, produced by transportation to the operating room, *etc.*, does not come down to 120, or thereabouts, under anesthesia, it may be preferable to send the patient back for further medical care. On the other hand, it might appear that the patient would be a safe subject for removal of one lobe only.

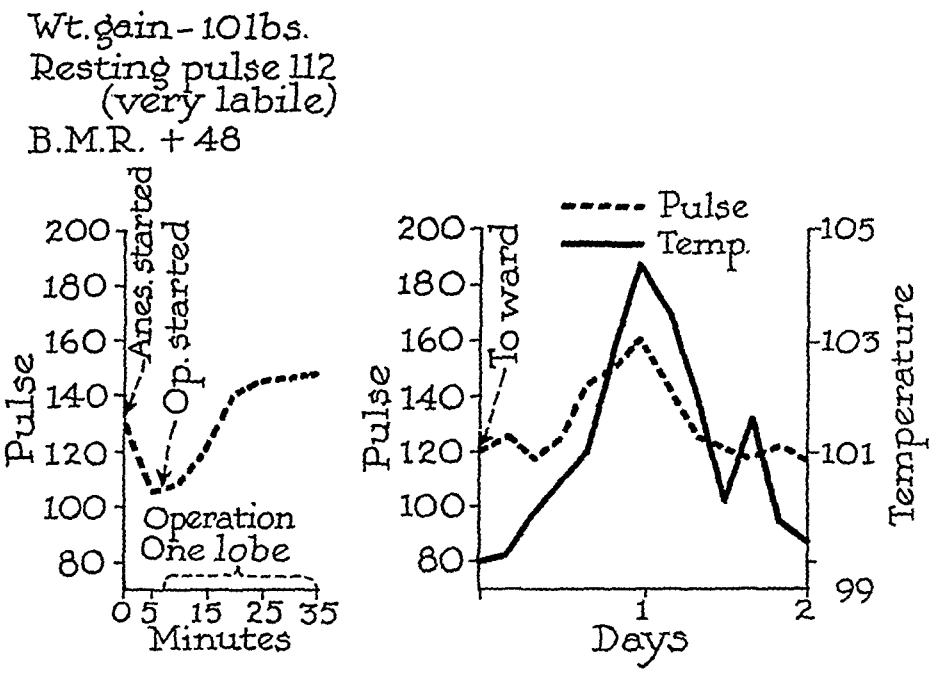


CHART 1.—The graph on the left shows the pulse rate during operation upon a fairly toxic patient, requiring a lot of oxygen during the anesthesia. In view of the elevation of pulse rate and high oxygen consumption, only one lobe was removed. The temperature and pulse curve on the right, indicative of a moderate crisis, suggests that more operative work might have resulted in a crisis threatening life.

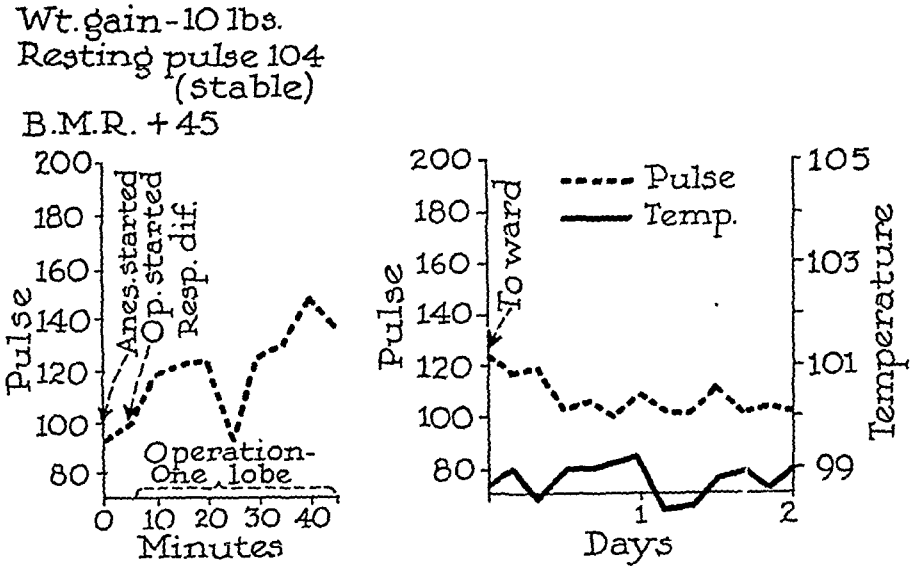


CHART 2.—The graph on the left shows the pulse rate of a patient (slightly less toxic than the patient in Chart 1) during operation. Respiratory difficulty due to laryngeal spasm was very troublesome throughout. The sharp temporary drop in heart rate occurred when cyclopropane was begun in an effort to increase the percentage of oxygen in the gaseous mixture. The pulse rate continued to rise. We were unable to tell whether the increasing tachycardia was due to toxicity or anesthesia complications, but decided it was preferable to remove only one lobe. The relatively quiescent postoperative course suggests the tachycardia during operation was more related to anesthesia complications than to toxicity.

Anesthesia.—The author agrees with Lahey[3] that local anesthesia is undesirable, particularly in patients who exhibit more than a moderate degree of toxicity. Naturally, when mild toxicity is present, local anesthesia will not instigate the development of sufficient psychic trauma to jeopardize the patient's condition. On the other hand, when the patient exhibits a marked degree of toxicity, he may suffer sufficient psychic trauma to produce a pronounced tachycardia and other manifestations sufficiently severe to actually jeopardize his operability. It is remarkable to note how often anesthesia will control the tachycardia which develops during preparation for operation. In this clinic we prefer ethylene as the anesthetic agent. Lahey uses cyclopropane in the majority of cases. Water[8] uses nitrous oxide to a great extent, but states that if conditions are not satisfactory under this agent he is prepared to resort to a different one. Since nitrous oxide anesthesia prevents the use of a very high concentration of oxygen, it will, naturally, require more skill in its administration. It should be emphasized, very strongly, that cyanosis is a complication to be avoided. Although it may occur from time to time during the operation, the anesthetist should be acquainted with the fact, and resort to active measures to correct it. If anoxia is severe, and is allowed to persist over a long period of time, it is even possible that permanent cerebral damage may result. Degenerative changes have been noted experimentally in animals by Thorner and Lewy[9] after repeated anoxia. By careful observation and cooperation with the anesthetist, it is usually possible to determine from the patient's breathing (under ethylene anesthesia) when the recurrent laryngeal nerve has been damaged. Obviously, if the damage is incident to pressure of an hemostat, removal of the clamp will correct the condition. If the damage consists of sectioning of the nerve, immediate repair will be indicated.

On certain occasions intratracheal intubation will be distinctly indicated. In all patients who have a significant degree of tracheal obstruction, it is usually preferable to insert a tube in the trachea, after anesthesia is obtained. If respiratory difficulty is encountered during induction, and cannot be corrected, such a patient will, likewise, be a candidate for intratracheal anesthesia. It should be emphasized, however, that the surgeon is handicapped slightly by the presence of the intratracheal tube, because he will be unable to detect when clamps may have been put on, or too near, a recurrent laryngeal nerve. The tube should be taken out before the wound is closed, to be certain that the airway is patent. If the nerves have been injured it may be necessary to perform an immediate tracheotomy. Obviously, if this is not discovered until the wound is closed, so much time may be lost in performing the tracheotomy as to jeopardize the patient's life.

The proper administration of premedication drugs is important in allaying apprehension and making smooth anesthesia possible. We favor giving 1.5 gr. of phenobarbital the evening before operation, and giving morphine grain ¼, with scopolamine grain 1/150, about one hour before operation. If toxicity is severe more morphine can be given later. As a basal anesthesia,

eliminating psychic shock produced by preparations for operation, avertin (rectally) may be given to patients, unless severe toxicity exists. However, in a study[10] made in this clinic, on the effects of avertin, it appeared that the drug actually reduced the operability by increasing the pulse rate, *etc.* We abandoned its use and believe that it, particularly, should not be given to patients with severe toxicity.

Extent of Operation.—Since the advent of iodine in the preoperative treatment of thyrotoxicosis most surgeons have abandoned polar ligation, with the idea that removal of a single lobe (followed by removal of the other lobe in about six weeks) may be substituted for that procedure. As previously implied, the pulse rate and its response to physical activity, *etc.,* will be an important indication as to the patient's toxicity. The author is of the opinion that pulse rate is perhaps the most important single factor in determining operability, and the possibility of severe postoperative reaction. If there has been difficulty in obtaining a sufficient improvement in the patient's symptoms to make operation safe, a decision can often be made preoperatively that the operation should be done in stages, removing a lobe at a time. If the patient's condition has been so questionable as to lead one to this conclusion, it will rarely be justified to change the opinion during the operation in favor of a bilateral lobectomy, even though the patient's condition through the operation seems satisfactory. If the patient's pulse rate does not come down to 120, or thereabouts, under anesthesia, or if it makes frequent excursions to a higher level, without explanation from the standpoint of anesthesia, the patient's *operability for a bilateral lobectomy will be in question.* Under such circumstances it will obviously be wise to remove only one lobe. There are a few surgeons (Richter, and associates[11]) who are of the opinion that operation in two stages does not diminish the dangers incident to operation, and does not reduce mortality rate. Lahey is probably one of the strongest advocates of the two-stage procedure, utilizing it in approximately 22 per cent of his cases. Considerable argument arises as to the amount of tissue to be removed. It appears safe to state that in patients who are mildly toxic and who have a very large goiter, the thyroidectomy need not be very complete. In such instances several grams of tissue may be left on each side without the danger of recurrence. In patients who have a relatively small gland, but whose toxicity is pronounced, the thyroidectomy must be fairly complete, leaving no more than 1 or 2 Gm. of tissue on each side along with the posterior capsule. It is, of course, well-known that recurrence is extremely uncommon in toxic nodular goiter. However, persistence of toxic symptoms can readily take place in this disease, explained by the fact that insufficient tissue was removed. Cattell and Morgan[12] have called attention to the fact that in recurrent thyrotoxicosis, the excision of glandular tissue must be more complete. In fact, if nerves and the parathyroids can be avoided, it is fairly safe to direct the operation toward a complete thyroidectomy, assuming that a few shreds of tissue will be left with the posterior capsule.

Precautions In Technic.—Although there is an obvious indication for completion of the operation in as short a time as possible, it should be emphasized that carefulness must not be sacrificed for speed in the operative procedure. Moreover, the teachings of Halsted have convinced us that gentle handling of tissue with careful technic in ligation of blood vessels, *etc.*, will pay good dividends in results including mortality rate. Only occasionally will it be necessary to cut the sternohyoid muscle transversely. However, when exposure is poor, the surgeon *should not hesitate* to do so; by so doing many difficulties and accidents will be prevented. If the operator has decided to undertake a fairly complete thyroidectomy extreme care must, naturally, be taken lest the recurrent laryngeal nerves be injured. To counteract this possibility through accident, Lahey isolates the nerve in every case. The author, however, does not employ this routine. When thyroidectomy is fairly complete, all nodules of tissue resembling parathyroid bodies should be transplanted back into the wound. All ligatures, particularly of the large vessels, should be tied securely. In fact, it is a fairly safe routine to put a double ligature on the superior pole, and the major branch of the inferior thyroid artery. Silk or catgut may be used for ligature. The author, however, prefers the use of silk, largely because drainage can be eliminated, and because wounds as well as postoperative reaction will be improved sufficiently to allow the patient's discharge at an earlier date. The most serious errors in technic are injury to the nerve, excision of parathyroids, and removal of inadequate thyroid tissue. Perhaps the most serious of these three errors is injury to the recurrent laryngeal nerve, particularly if it is bilateral. Damage to nerves will be greatly minimized if the surgeon changes his position from the patient's right to left, as he proceeds from excision of the right to left lobe, particularly if exposure is poor. Injury of one nerve will not produce complete respiratory obstruction, but is apt to result in hoarseness or loss of voice with only mild obstruction to breathing. Occasionally, no symptoms are noted by the patient, although laryngoscopic examination may reveal one cord to be paralyzed. If both nerves are injured the resultant bilateral paralysis will result, almost invariably, in complete obstruction to breathing, requiring an immediate tracheotomy. Up to a few years ago, very little could be offered to these patients. Rarely could the tracheotomy tube be removed. A short time ago, Hoover[13] reported relief of the respiratory obstruction by submucous resection of the cord. A much more promising procedure, however, is that recommended by King,[14] consisting of dislocation of the arytenoid cartilage with fixation by suture so that the cord is pulled away from the midline. From preliminary results, it appears that this operation will be successful in eliminating respiratory obstruction in the vast majority of cases of bilateral nerve injury.

Postoperative Treatment.—Before leaving the patient, the anesthetist returning with him must be certain that the air-way is open, and that the patient is breathing without difficulty. The bandage should be inspected to be sure that it is not applied too tightly, an error which is apt to be encoun-

tered, not infrequently, because of the haste with which they are frequently applied in the operating room.

(1) *Position in Bed.*—The patient should be placed in a semisitting position with the back-rest up. This will be much more comfortable for him than lying down, and will facilitate swallowing. It also aids considerably in breathing.

(2) *Intravenous Fluids.*—All patients with toxicity should have intravenous glucose started immediately upon return to the ward. The amount will depend upon the degree of toxicity. If they are only mildly toxic, 1,000 cc. of 5 per cent solution will be sufficient. If toxicity is fairly severe, 3,000 cc. of 5 per cent will be indicated for the day of operation. It is given in decreasing amounts for the first one or two days postoperatively—the quantity determined by the degree of toxicity and amount of fluid and food taken by mouth.

(3) *Oral Fluids.*—Although there will be slight discomfort incident to swallowing, with slight urging the patient will be able to do so, and after a few attempts will swallow without significant discomfort. Cold fluids, consisting largely of sweetened fruit juices, should be allowed immediately after operation, as tolerated. In our experience, oral fluids cannot entirely displace intravenous fluids, yet they are given in as large quantities as will be tolerated. Rarely will the patient be able to take more than 1,000 cc. the day of operation.

(4) *Administration of Lugol's Solution.*—It is not certain just how much benefit is obtained by the postoperative administration of iodine. However, when a subtotal thyroidectomy is performed, leaving a small amount of thyroid tissue, it is the consensus of opinion that iodine should be given postoperatively. In this clinic, a large dose, consisting of 5 cc. is given rectally in 200 or 300 cc. of water. In addition, the patient is placed on 10 M. three times a day for a few weeks until all evidence of hyperthyroidism has disappeared.

(5) *Watch for Respiratory Difficulty.*—Respiratory difficulty represents one of the serious emergencies in postoperative care. If it is not recognized early, a fatality is apt to result. It may be caused by either one or two complications, namely, (1) postoperative hemorrhage; or (2) injury to the recurrent nerves. If a postoperative hemorrhage has developed, the first demonstrable evidence is usually difficulty in breathing. If a drain has been placed in the wound there will be considerable blood on the dressing, but rarely does the drain prevent compression of the trachea in vigorous bleeding, because clots form and block the exit. Early in the postoperative hemorrhage, inspection of the wound will reveal nothing more than slight swelling, which *will not be detected* by an inexperienced intern. As the hemorrhage progresses the respiratory obstruction will increase to the point where cyanosis appears. This is a *late symptom and demands immediate action* to prevent a fatality. The wound should be opened and the clot evacuated. The bleeding point is then found and ligated. If unable to find the bleeding

point, gauze should be packed into the operative field with the wound left open. If the emergency treatment has been delayed, tracheotomy will frequently be necessary, presumably because of edema and extravasation involving the nerves. This adds an additional source of danger because of infection of the wound which is apt to result. If the respiratory difficulty is associated with bilateral nerve injury, tracheotomy will almost invariably be necessary. If the patient was breathing satisfactorily upon return to the ward, but developed respiratory obstruction a few hours later, it is safe to assume that both nerves had not been severed; edema may produce this complication with or without injury to one nerve. Tracheotomy may still be necessary, particularly if the obstruction is sufficient to produce cyanosis. There is a great tendency to delay tracheotomy too long. It is a well-known fact that if the patient is to be saved it must be performed early, before cyanosis has been present very long.

(6) *Oxygen Therapy for Tachycardia.*—If the patient's toxicity is sufficient to produce a tachycardia above 130 to 140, postoperatively, oxygen therapy will be strongly indicated. It has been our experience that tachycardia can be reduced appreciably by oxygen therapy. If the cardiac embarrassment is sufficient to produce cyanosis, oxygen therapy becomes even more urgent. It may be administered in one of three ways: (1) By intranasal catheter; (2) by mask; and (3) by tent. The intranasal method is so simple that we employ it almost to the entire exclusion of the other procedures. Occasionally, the presence of the catheter or tube in the nose will be a source of considerable discomfort. If it produces nausea and vomiting, the tube will be found to be protruding too far posteriorly. If this method is uncomfortable, either a mask or tent may be used. If an oxygen tent is used, the situation must be explained carefully to the patient lest he consider the procedure a symbol of impending death, and work himself into a serious state of psychic shock through worry. Occasionally cyanosis will develop solely because of cardiac damage in the absence of significant toxicity. Such a situation will be encountered chiefly in the elderly patients, suffering from toxic nodular goiter, with cardiac symptoms of many months' or years' duration.

(7) *Sedation.*—All patients during the first few days, postoperatively, must be given sufficient phenobarbital, morphine, *etc.*, to insure rest and sleep, particularly at night. It has been our experience that patients with moderately severe thyrotoxicosis will have their symptoms exaggerated markedly if they are not given ample morphine to insure sleep the first one or two postoperative nights. Because of the increased basal metabolic rate these patients will be able to tolerate larger and more frequent doses of morphine than the average individual. A daily dose of a sedative such as phenobarbital is just as important during the first few postoperative days as in preoperative treatment; after the first night or two it should supplant morphine. The patient will have to be watched closely to determine what the optimum dose of sedatives should be. Obviously, any dose of morphine which depresses the respiratory rate is too large. If an overdose is given

cyanosis may develop and be a serious complication. If this occurs, oxygen therapy must be instituted at once.

(8) *Miscellaneous Procedures.*—It is extremely important that the patient be kept cool, and not have too many covers. There is a great tendency on the part of nurses to cover patients with too many blankets upon arrival from the operating room. Keeping the patient warm is, of course, an important precaution in the average postoperative patient, but in hyperthyroidism, the heat production is already so pronounced that the application of more than a light blanket will tend to result perhaps in actual heat stroke, particularly in warm weather. Naturally, a patient with severe toxicity should not be submitted to thyroidectomy on a hot day. If the weather suddenly turns hot, it will be necessary to use ice-bags, electric fans, *etc.*, or even an air-conditioned room. The patient should be placed in a room by himself if possible, but this is by no means necessary. Perhaps the only precaution of importance in this respect is that he not be placed next to a moribund patient, or one complaining bitterly. At times, the presence of calm patients next to the patient seems to add to his comfort, particularly if adequate sedation is given for rest and sleep at night.

All patients should be watched for the development of tetany. Early symptoms would be numbness and tingling of the hands, positive Chvostek's sign, carpopedal spasm and awkwardness in using the hands. If tetany develops, the immediate administration of calcium is indicated. It is commonly given intravenously as calcium gluconate, in doses of 5 cc. of 10 per cent solution two or three times daily as indicated. If calcium therapy along with inclusion of milk in the diet does not relieve the patient, parathormone will be necessary. One ampule three times a day will suffice even in severe cases. During the postoperative convalescence the wound must be watched for complications other than hemorrhage, as already discussed. Naturally, if an infection develops the wound must be opened and drainage established. If serum collects, it should be aspirated since its accumulation will encourage the development of infection. Infection will be much less frequent when silk has been used but will be more serious. We have had a few instances of infection with prolonged drainage in our patients in whom silk was used, but none who drained longer than a few weeks; exploration of the wound with removal of two or three sutures may at times be indicated.

Treatment of Crisis.—Naturally, the most important feature in the treatment of crisis is prophylactic, insofar as a patient developing a crisis is usually so toxic that operation should not have been performed at that time. There is no question but that hot and humid weather increases the tendency toward the development of crisis postoperatively. As noted above, severely toxic patients must not be submitted to operation on hot days. If this cannot be avoided the patient should be treated with ice-bags, electric fans, *etc.*, or preferably placed in an air-conditioned room, immediately upon return from the operating room. If crisis has developed this feature in therapy becomes more important, and in the author's estimation is the most important factor in therapy. Naturally, an air-conditioned room is preferable but not

necessary, if the beneficial effects of ice-bags, wet towels, and electric fans are taken advantage of. One need not fear the development of pneumonia in these patients, by the application of innumerable ice-bags and wet towels. The amount of sedatives required will be increased over that in the average patient. In addition to morphine, it is usually advisable to give an additional sedative such as phenobarbital (perhaps the soluble sodium salt hypodermically). The fluid intake must likewise be increased, up to at least 5,000 cc. per day, depending upon the patient's temperature. These patients will rarely be able to take much by mouth, and even if they do, will probably vomit most of it. It will, therefore, be necessary to administer most of the fluid intravenously as 5 or 10 per cent glucose. This is absolutely essential, and no excuses to the contrary are acceptable, except in severe cardiac decompensation, which in reality is rarely seen in crisis except as a terminal manifestation. An attendant may have to be assigned to holding the patient's arm, but in our experience, the arm can be fixed adequately with bandages, *etc.*, even though the patient is mildly delirious. Oxygen therapy, as previously described, is extremely important, and should be instituted as soon as impending crisis is detected. Sodium iodide should be given intravenously in doses up to 1 Gm., once or twice a day as indicated.

COMMENT.—Since the advent of iodine in the preoperative care of thyrotoxicosis, very few instances of crisis are observed postoperatively. As stated previously, if a crisis develops, it can be said, definitely, that an error has been made in the date or extent of operation. In spite of all precautions, there undoubtedly will be a small mortality rate, perhaps as high as two- or three-tenths of 1 per cent, because of unpreventable accidents. The incidence of natural death alone in a large series of patients during several days' hospitalization will in itself prevent establishment of a mortality rate of zero except by coincidence. Moreover, occasionally, complications will develop which are in reality secondary to the operation but which appear unpreventable.

The higher mortality rates as reported in the South over the figures in the North are difficult to explain. At first glance, it would appear to be related to the higher incidence of Negroes in the thyrotoxic patients. This explanation is not clear-cut for several reasons. For example, in one series in the South, the highest mortality rate was encountered in Negro females, whereas in another series (Maes and Romano[15]) the highest mortality was encountered in Negro males. Moreover, in our series of 478 thyroidectomies for toxic goiter, as performed during the past four and one-half years, we had no deaths, whatsoever, in the 42 Negro patients in that series; it is possible, of course, that the Northern Negro is better nourished than the Southern Negro. It would appear then that longer preoperative therapy would be indicated, and that weight gain *must be greater* than in the average patient.

In our series of 581 operations (Table I), we had six deaths, with a mortality rate of 1.03 per cent for the entire series. Of this group, how-

TABLE I

TYPES OF GOITER AND MORTALITY (1936–1940)

Type	Operations	Deaths	Mortality	
Toxic-diffuse	277	3	1.08%	1.25%
Toxic-nodular	201	3	1.44%	
Nontoxic-nodular	103	0	0	
Total	581	6	1.03%	

In toxic group 42 Negroes (9 per cent)—no deaths.
All six deaths were in white females.

ever, 103 were nontoxic, making the mortality rate for the 478 toxic patients 1.25 per cent. In the toxic series, we resorted to a two-stage operation in 7.5 per cent of the cases. In a goiter belt, where there is such a high percentage of patients with an initial basal metabolic rate of above 50, this incidence of 7.5 per cent is probably too low. In the group of 581 cases submitted to thyroidectomy only 18 per cent were nontoxic nodular goiters. This is perhaps not an accurate estimation of the incidence of nontoxic nodular goiter in the Chicago area, since our hospital is too small to care for all of our dispensary patients, and preference for hospitalization is given to the toxic group.

Of six patients dying following operation, two succumbed to crisis; one to gas gangrene of the buttocks; one to postoperative hemorrhage; one to tetany; and one to acute hepatitis. All of these deaths were in white women. At least half of them were preventable including, particularly, the two patients in crisis, and the patient dying from postoperative hemorrhage. Neither of the two patients dying from crisis fulfilled the prerequisites as outlined herein. In retrospect, therefore, we classify them as errors in the choice of time of operation. There is, perhaps, no doubt that the patient who died from hemorrhage into the neck wound, could have been saved by more careful observation postoperatively, with opening of the wound, evacuation of the clot, *etc.* The operations in the entire series were performed by 12 different surgeons.

Undoubtedly, hepatic insufficiency is a contributing cause of death in many instances. The presence of cellular necrosis of the liver in patients dying of thyroid disease has been known for decades. Boyce and McFetridge[16] have shown that tests of hepatic function (hippuric acid test) indicate the presence of hepatic insufficiency in a great percentage of thyroid patients. In a series of 24 fatal cases of toxic thyroid disease, as reported by Shaffer,[17] there was an average decrease in weight of the liver of slightly over 300 Gm. in the patients dying of thyroid disease. However, in a study of patients dying from thyrotoxicosis, Foss, and associates[18] were unable to find a very direct relationship of the amount of hepatic damage to the severity of the crisis.

SUMMARY

The most important features in lowering mortality rate in thyroidectomy for toxic goiter consist of adequate preparation of the patient, and choice of

time for the operation. Postoperative care, as well as the extent of the operation (*i.e.,* one- or two-stage operation), are likewise important. By adhering to certain principles it seems definite that mortality can be kept low (1 per cent or less), by eliminating all of the deaths from crisis, and many of the deaths resulting from complications in the presence of a mild crisis. It is impossible to make several rules apply to each individual patient. In general, however, we utilize gain in weight, basal metabolic rate of below 50, resting pulse rate below 110, and response to iodine, as prerequisites for operation. If these prerequisites cannot be met, it will be necessary to postpone operation awaiting a remission, or to submit the patient to removal of one lobe only. Intravenous glucose is extremely important in the postoperative care, and should be instituted in all patients, except perhaps those with very mild toxicity.

REFERENCES

[1] Crile, George, Jr., and McCullagh, E. P.: Hypertension Simulating Hyperthyroidism. Med. Clin. North America, **24**, 395, 1940.

[2] Bisgard, J. D.: Relation of Hyperthyroidism to Hypertension. Arch. Int. Med., **63**, 497, 1939.

[3] Lahey, F. H.: The Surgical Treatment of Thyroid Disease. New Eng. Jour. Med., **221**, 978, 1939.

[4] Lehman, E. P., and Shearburn, E. W.: Thyrotoxicosis. ANNALS OF SURGERY, **109**, 712, 1939.

[5] Daniels, L. P.: On the Significance of the Various Phenomena of Basedow Complex. Acta Med. Scandinav., **98**, 561, 1939.

[6] Womack, N. A.: Preoperative and Postoperative Treatment of Toxic Goiter, Arch. Surg., **40**, 1123, 1940.

[7] Puffel, I. D., Klassen, K. P., and Curtis, G. M.: Calcium Metabolism in Thyroid Disease. The 1939 Transactions of the Amer. Assn. for Study of Goiter, 221; Puffel, I. D., and Curtis, G. M.: Arch. Int. Med., **58**, 957, 1936.

[8] Waters, Ralph: Personal communication.

[9] Thorner, M. W., and Lewy, F. H.: The Effects of Repeated Anoxia. J.A.M.A., **115**, 1595, 1940.

[10] Cole, W. H., and Brunner, Robbie: Anesthesia in Thyroidectomy for Thyrotoxicosis. Surg., Gynec., and Obstet., **70**, 211, 1940.

[11] Richter, H. M., Mora, J. M., and Wagner, D. H.: One-Stage Thyroidectomy for Thyrotoxicosis in Aged. Surg., Gynec., and Obstet., **69**, 178, 1939.

[12] Cattell, R. B., and Morgan, E. S.: Recurrent Hyperthyroidism. Surg., Gynec., and Obstet., **68**, 347, 1939.

[13] Hoover, W. B.: Bilateral Abductor Paralysis: Operative Treatment by Submucous Resection of the Vocal Cords. Arch. Otolaryng., **15**, 339, 1932.

[14] King, B. T.: A New and Function-Restoring Operation for Bilateral Abductor Cord Paralysis. J.A.M.A., **112**, 814, 1939.

[15] Maes, N., and Romano, S. A.: Thyroid Disease in a Nonendemic Area. ANNALS OF SURGERY, **111**, 275, 1940.

[16] Boyce, F. F., and McFetridge, E. M.: Studies on Hepatic Function by the Quick Hippuric Acid Test. Arch. Surg., **37**, 427, 1938.

[17] Shaffer, J. M.: Disease of the Liver in Hyperthyroidism. Arch. Path., **29**, 20, 1940.

[18] Foss, H. L., Hunt, H. F., and McMillan, R. M.: Pathogenesis of Crisis and Death. J.A.M.A., **113**, 1090, 1939.

MEDIASTINAL GANGLIONEUROMA*

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GANGLIONEUROMATA form a specialized group of more differentiated tumors originating from the sympathetic nervous system. Consequently, they may, fundamentally, arise from primitive cells originating within the neural crest; or later from sympathetic ganglia, or even within the adrenal medulla. Thus they are related, on the one side, to the less differentiated and more malignant sympathicoblastoma or neuroblastoma, and, on the other, to the pheochromocytoma. Examples of the latter group occur clinically, as certain carotid body tumors or as the "carcinoid of the appendix."

While these well-differentiated tumors, originating from nervous tissue, may occur throughout the body, the majority are particularly found along the course of the major chain of sympathetic ganglia. Thus they commonly occur in the neck, thorax, abdomen and pelvis. Others appear within the cranium or along the course of certain of the cranial nerves. The majority appear to be tumors with a low tendency toward malignancy. In some respects, they may even resemble fibrosarcomata.

Ganglioneuromata were doubtless seen, although not recognized, by Odier, as early as 1803. In his comprehensive work "Die Krankhaften Geschwülste," published in 1863, Virchow used the term "neuroma" to designate the component group. At that time he even separated nerve tumors into true and false neuromata. Loretz' paper, in 1870, "Ein Fall von gangliösem Neurom (Gangliom)," gave origin to the present term, and presented the first authentic case report. Loretz concluded that the tumor he was differentiating arose from a prevertebral sympathetic ganglion within the mediastinum.

The wide distribution as well as the differentiation of ganglioneuromata gradually became known. In 1891, Marchand, investigating a tumor removed from the adrenal gland, concluded that structurally it closely resembled embryonic sympathetic nervous tissue. Wright, in 1910, further developed our present concept of these, as well as other tumors arising from the sympathetic nervous system. He separated them from sarcomata, carcinomata and lymphosarcomata, with which they had previously been confused. Wahl's valuable paper, in 1914, presents a splendid summary of the knowledge current at that time.

Subsequent to Loretz' original report, ganglioneuromata of the mediastinum were but occasionally recognized and recorded. About 15 were reported previous to 1932, with two-thirds of these appearing after 1923.

*Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

FIG. 1. FIG. 2. FIG. 3.

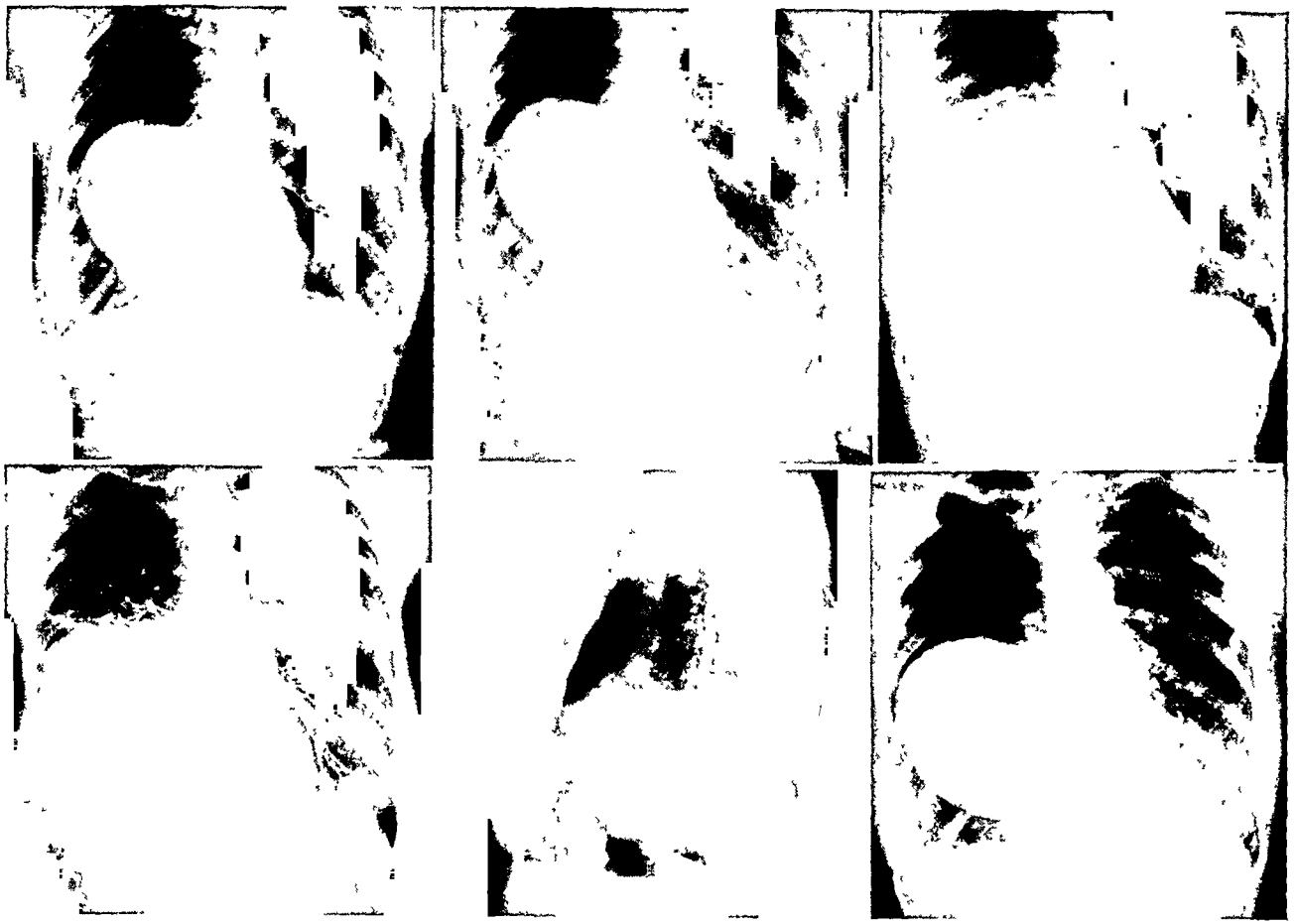


FIG. 4. FIG. 5 FIG. 6.

FIG 1.—Discovery of the tumor, August 20, 1931, by a routine chest roentgenogram Note the reflection of the pleura.
FIG. 2.—Three months later, November 10, 1931, there was no perceptible change. Note the lack of cardiac displacement.
FIG 3.—Basal pleural effusion, January 26, 1939, with some dyspnea.
FIG. 4.—Lipiodolization, April 5, 1939, revealed an anterior-lying lower right lobe
FIG 5.—Lateral view of tumor, April 6, 1940, outlined by pneumothorax Note the anterior-lying lower right lobe, and the fluid level.
FIG. 6.—Further pneumothorax completely collapsed the lung, and sharply delineates the tumor. The mediastinum remains fixed.

In 1929, Riggs and Good listed 65 recorded ganglioneuromata, but six of which had arisen within the thorax. In 1934, Bohrer and Lincoln again called attention to the infrequency of this form of mediastinal tumor.

With the recent development of thoracic surgery, this small list is definitely increasing. This is particularly due to the facility with which these tumors may be recognized roentgenologically, and removed by thoracotomy. In July, 1939, Allison and Carmichael were able to collect 19 cases. Their own case report, of an instance in which a mediastinal ganglioneuroma was successfully removed, reveals that it originated from the upper thoracic sympathetic chain.

Some uncertainty of classification yet remains. This concerns largely the interpretation of the varying degrees of differentiation observed, and especially as related to malignancy. However, while the tumor is admittedly rare, we have been able to collect more than 33 instances of what may reasonably be regarded as mediastinal ganglioneuromata. A chronologic bibliography of this series is presented.

To this latter group we are adding another that developed in the posterior mediastinum of the lower right chest of a young woman, age 35. This had grown to a size sufficiently large to cause respiratory embarrassment by the production of hydrothorax. As a consequence it was successfully removed by thoracotomy.

Case Report.—Hosp. No. 392148: R. K., a registered nurse, age 35, was referred to the Chest Clinic by Dr. David A. Tucker, of Cincinnati. She entered the University Hospital, April 4, 1939, complaining chiefly of dyspnea. The pertinent history dated back eight years, to 1931, at which time she entered nurses' training. Chest roentgenograms taken during her preliminary physical examinations revealed a tumor of considerable size in her right lower chest (Fig. 1). Moreover, when subsequently studied, this did not appear to be growing (Fig. 2).

She continued with her training and remained essentially symptom-free until about three and one-half months before admission, when she noticed an increasing dyspnea. During the course of the next two weeks, the respiratory difficulty became severe enough to incapacitate her. She also became conscious of palpitation. A roentgenogram, January 26, 1939 (Fig. 3), revealed considerable fluid in the lower half of the right chest, obscuring the tumor. Thoracentesis elsewhere, on three occasions had revealed considerable straw-colored fluid. Microscopic examinations of the sediment of the aspirated fluid did not reveal any malignant cells. She was subsequently given a series of 15 roentgen ray treatments, without obvious benefit. She noticed at times a nonproductive cough. There had been no weight loss. Her past and family history were noncontributory.

Physical Examination revealed a normal young woman, a little dyspneic on exertion. She had no fever, pulse 80, respirations 20, blood pressure 100/65.

The trachea was slightly deviated to the left. The chest appeared normal and revealed bilateral equal expansion. The left chest revealed a slight hyperresonance, and somewhat increased breath sounds. The lower right chest revealed flatness to percussion, and decreased to absent breath sounds and tactile fremitus posteriorly below the sixth rib. The anterior right chest also revealed dulness, as well as diminished breath sounds and tactile fremitus in its lower portion.

The vital capacity was 2,100 cc. Fluoroscopy showed the tumor to lie posteriorly. There was at that time a small amount of pleural transudate on the right side. The

tumor did not pulsate. The heart was not displaced, and the remainder of the chest was negative.

Laboratory Data.—The erythrocyte count was 4,560,000, with 13.5 Gm. of hemoglobin; the leukocyte count was 8,050 with 67 per cent segmenters, 2 per cent bands, 19 per cent lymphocytes, 10 per cent monocytes and 2 per cent eosinophil cells. The Wassermann and Kahn reactions were negative. Her basal metabolic rate was minus 17 per cent. Smears and cultures of the aspirated pleural fluid revealed no organisms.

Lipiodolization of the right lung was accomplished by the Singer method. This revealed a "puddling" in the right lower lobe bronchus at the point where the lower lobe was sharply compressed forward (Fig. 4). In fact, the right lower lobe was draped anteriorly over the tumor mass which also compressed upward the overlying lung (Fig. 5). Pneumothorax was commenced, both for its diagnostic value and as a preparation for the proposed widely open thoracotomy (Fig. 5). Thoracentesis again yielded 70 cc. of straw-colored fluid, which chemically and microscopically showed it to be an effusion. Pneumothorax was subsequently increased in stages until complete collapse of the right lung was obtained (Fig. 6).

On April 13, 1939, thoracotomy was performed and the tumor uneventfully removed before a visiting group from the Detroit Academy of Surgery. Under avertin and nitrous oxide anesthesia, with positive pressure available but found not necessary, an incision was made over the tenth rib posteriorly, and generous segments of the ninth and tenth ribs subperiosteally were resected. The pleura was opened through the periosteal bed of the ninth rib. This exposed a large grape-fruit-sized tumor, firmly attached along the lateral vertebral bodies in the region of the normal course of the lower thoracic sympathetic chain of ganglia. The pleura was obviously edematous and thickened, and the mediastinum well stabilized. In fact, after a brief safety period during which it became clear that the mediastinum was fixed, the operation was continued under ordinary anesthesia.

Adhesions between the lung and the upper, anterior pole of the tumor were first freed. The thickened pleura covering the tumor was then split and bluntly dissected away, leaving the uncovered tumor to project free into the pleural cavity. By blunt finger-dissection the tumor was then separated from the pericardium and the lower posterior mediastinal tissues. The adhesions were not dense and there was no infiltration. The tumor capsule was definite and shaggy. There finally remained a tough fibrous stalk attached along the lateral vertebral bodies, just posterior to the pericardium. The mediastinal pleura was then further separated, better exposing the attachment of the stalk and suggesting its intercostal blood supply. It was clamped, the tumor removed, and the stalk then ligated. The redundant mediastinal pleura was then plastically closed and anchored to the stalk stump. A mushroom catheter was then inserted through a posterior stab wound and the incision closed.

The preoperative blood pressure had been 90/60, and had fallen during the operation to 70/50. As a consequence, she was transfused immediately postoperatively. Upon return to her room, suction drainage was gradually instituted through the catheter and eventually maintained at 10 cm. of water pressure. The following day a portable roentgenogram showed the lung to be completely reexpanded.

Her temperature reached a height of 103° F. on the second day, and then gradually subsided to normal by the tenth postoperative day. A roentgenogram taken five days after operation showed but slight pleural reaction at the right base (Fig. 7). On the eleventh postoperative day, lipiodol was injected through the catheter at moderate pressure; however, no residual pocketing could be demonstrated. The catheter was consequently removed. She was allowed up on the twelfth day and discharged on the seventeenth day.

She returned to the Chest Clinic for check-up about two months later. At that time, she had no complaints; she had gained weight and noted no symptoms. The chest examination was negative. The vital capacity had increased 300 cc., and was 2,400 cc.

Stereoscopic roentgenograms still revealed some density at the right lower base. Repeated subsequent examinations have revealed no unfavorable sequelae.

On July 11, 1940, 15 months postoperative, her vital capacity had increased 600 cc.—to 2,700 cc. Throughout, there has been no evidence of malignancy. She has maintained her weight-gain and remains in excellent physical condition. Improvement is further shown by the roentgenogram taken that day (Fig. 8). She is carrying on her usual work.

FIG. 7.



FIG. 8.

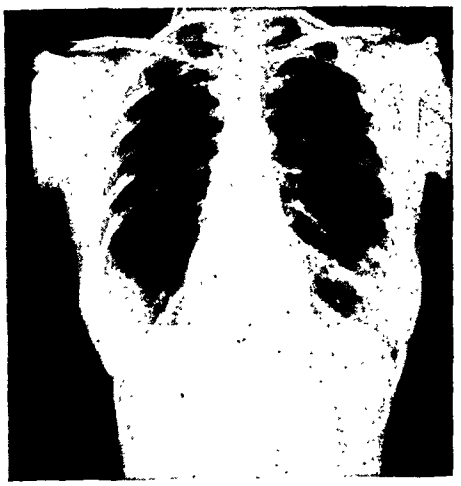


FIG. 7.—By means of catheter suction the lung has reexpanded, five days postoperative.

FIG. 8.—Fifteen months postoperative, July 11, 1940, there is little abnormal to be noted save the absence of ribs 9 and 10 posteriorly.

Pathologic Examination.—Gross: Upon sectioning the tumor soon after its removal (Fig. 9), the predominance of a soft matrix, which resembled myxomatous tissue, caused us originally to regard it as of mesodermal origin. And we are, consequently, greatly indebted to Dr. Harry L. Reinhart, pathologist to the University Hospital, whose investigation led to the recognition of its neurogenic nature. He has furnished us with the basis for the following description of the principal pathologic findings.

The tumor was a large, ovoid, encapsulated mass, measuring 13x10x9 cm., and presenting a rough fibrous area (Fig. 9 A) of attachment at the mediastinum. The remainder of the capsule was unbroken. The surface was shaggy, due to the separation of the overlying pleura. Two cysts were present, both containing hemorrhagic fluid. Three types of tissue were evident: (1) Extensive edematous to myxomatous appearing areas, interspaced by (2) areas of a more fibrous character, which were yellowish in color and arranged in an irregular lattice network; and (3) areas of hemorrhage. The capsule was not invaded.

Microscopic.—Examination revealed a predominance of loose, edematous fibrillar stroma, presenting but few cells (Fig. 10). Scattered irregularly and sparsely throughout this stroma are found nests of cells (Fig. 11) whose nuclei differ from the oval to pyknotic nuclei of the stroma. These cells are, in certain areas, closely related to a more dense fibrillar stroma (Fig. 12). When differentiated by trichrome stain and examined under high power they present a series, beginning with round nuclei and a

moderate amount of cytoplasm, suggestive of plasma cells, and ending with sympathoblasts and an occasional multipolar sympathetic ganglion cell (Fig. 13). The cellular development within these groups is, to a considerable extent, at the sympathoblastic and neuroblastic stage of differentiation. Mitotic figures are very scarce; however, cells containing from two to four nuclei are common. Cellular degeneration is prominent even in these cell groups, and varies from cytoplasmic vacuolization and nuclear pyknosis to focal areas of granular detritus where apparently entire nests of cells have undergone degeneration. This picture is so pronounced that, were it not for the large amount of fibrillar material remaining, the proliferative and neoplastic character of the growth might be easily overlooked.

The character of the cells and the production of large amounts of fibrillar tissue together with the disappearance, to a large degree, of the cells responsible for the production of such material, stamp the tumor as a ganglioneuroma.

In the light of the inherent biologic character of ganglioneuromata these features warrant the assumption that the tumor has been slowly progressive over a period of several years, while the encapsulation and low rate of cellular proliferation suggest a relatively benign histologic character. McFarland and Sappington presented an excellent study of the more detailed histologic features of ganglioneuromata, most of which are duplicated in this tumor.

Discussion.—The anlage of the sympathetic nervous system appears relatively early in the embryo, as cells of the neural crest. According to Kuntz, the sympathetic primordium consists of cells which migrate outward in varying degree from the neural crests. These cells have been designated sympathogonia. They develop into slightly larger cells with more vesicular nuclei —the sympathoblasts. These cells are pluripotential and may, according to Bailey, give rise to (a) neuroblasts—from which the ganglion cells of the sympathetic nervous system develop; (b) pheochromocytes of the adrenal system; or (c) astroblasts—glial cells of the sympathetic system which ripen into astrocytes.

A classification of tumors arising from these cells and showing the relations and position of ganglioneuroma, as presented by Scott and Palmer, is as follows:

(I) Completely undifferentiated—Sympatheticoblastoma:
 (1) Tumors composed of migratory cells and sympathogonia.
 (2) Sympathoblastoma.
(II) Incompletely differentiated:
 (1) Sympathetic neuroblastoma.
 (2) Pheochromoblastoma.
 (3) Astroblastoma.
(III) Completely differentiated:
 (1) Ganglioneuroma.
 (2) Pheochromocytoma.
 (3) Astrocytoma.

The neuroblastoma is the most common type found in children and arises frequently in the suprarenals. The true ganglioneuroma is rare in children. It is considered benign when found early in its development. Formative cells

are not present. Adult ganglion cells have been found in the adjacent lymph nodes in a few instances and have been described as metastatic. It has been demonstrated that typical ganglioneuromatous elements may occur in malignant metastasizing tumors. Cushing and Wolbach reported an instance in which the tumor reverted from a malignant sympathoblastoma to a benign ganglioneuroma.

FIG. 9. FIG. 10.

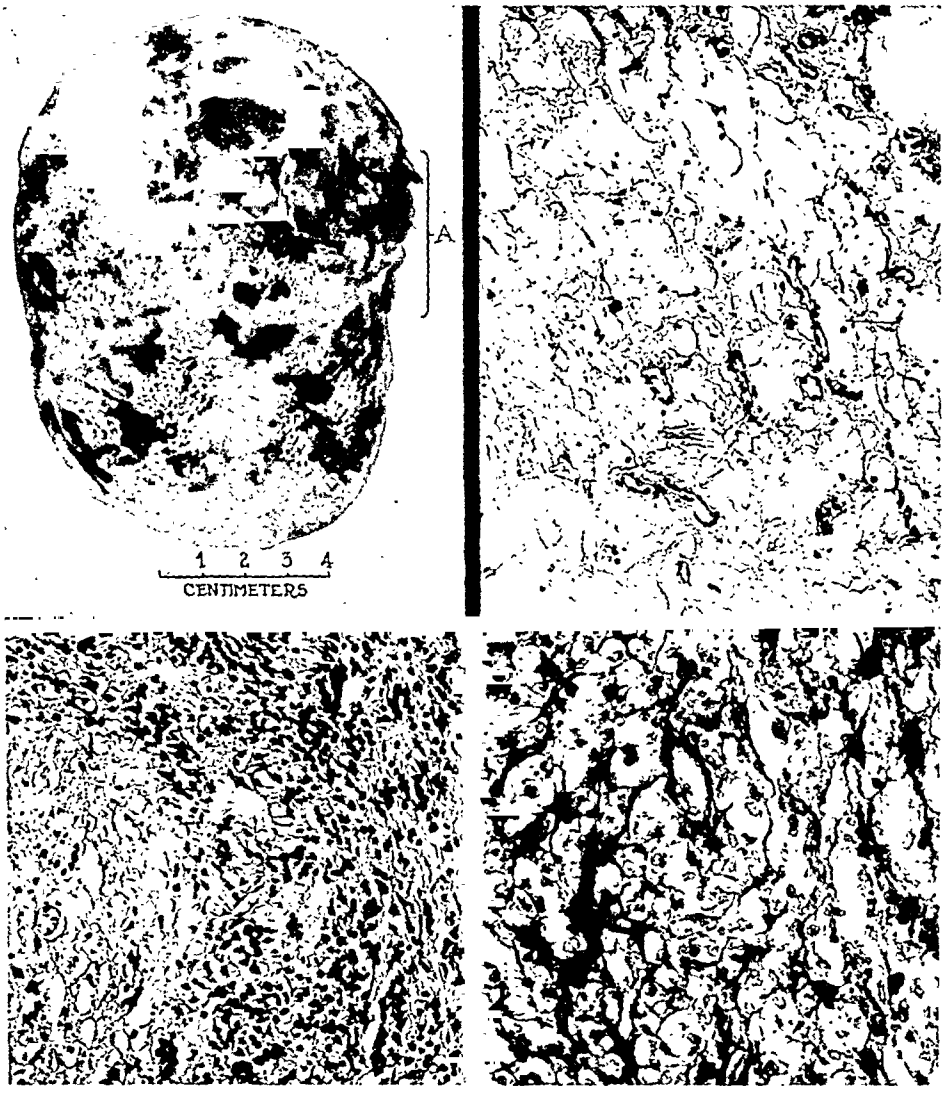


FIG. 11. FIG. 12.

FIG. 9.—Median section through the tumor. Note the smooth capsule, the attachment at A, and the three types of tissue.

FIG. 10.—The loose myxomatous fibrillar stroma which predominated throughout the tumor.

FIG. 11.—Presents nests of nerve cells within a loose stroma. (Trichrome stain—×240.) Note the vascularity of the tumor.

FIG. 12.—The relation of cells to fibrils in a more cellular area of coarsely fibrillar stroma. (Trichrome stain—×570.)

Bigler and Hoyne reviewed a group of 97 cases of ganglioneuroma, collected up to 1931. They found that the more benign the tumor the more advanced was the age incidence. Forty-one cases occurred in children, and 43 in adults. The youngest patient was a new-born infant, the oldest was

age 73. The sex was given in 79 cases. Of these, 46 were females, and 33 were males. Distribution was given in 90 cases, as follows:

Brain	15
Cranial nerves in head	7
Neck	11
Mediastinum	11
Retroperitoneally, and in pelvis	46

Where the side of the body was given, 29 occurred on the left, and 22 on the right. Thirty-nine cases were operated upon. Thirty-four of these recovered, and five died.

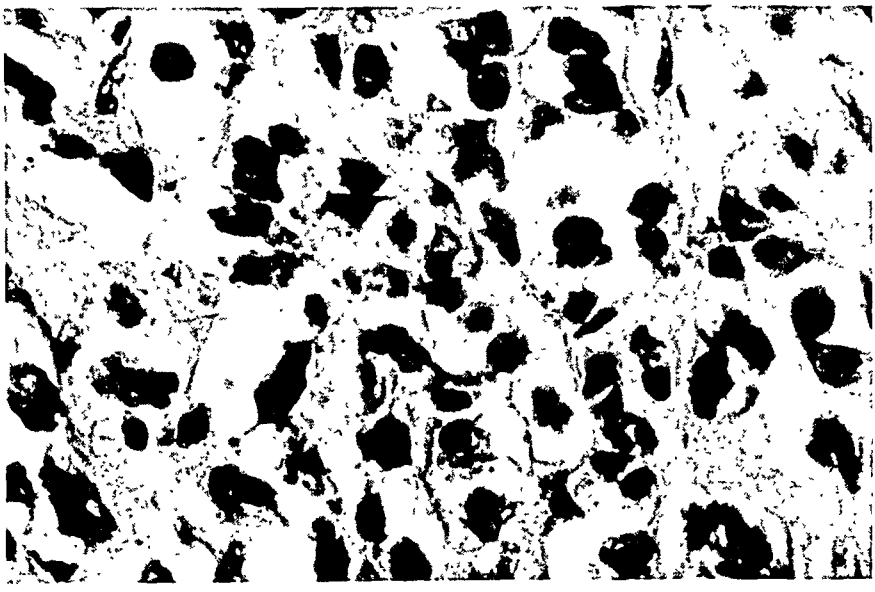


FIG. 13.—Various stages of cellular differentiation including multipolar ganglion cells. (*Trichrome stain*—×800.)

Even though embryonic elements were found to be present, removal of the tumor led to recovery without recurrence of the growth or the development of subsequent metastases. In operable cases, therefore, the prognosis would appear to be good even though evidence of undifferentiated cells later appears during microscopic study. The only suitable treatment appears to be surgical removal. Roentgenotherapy has been tried, without apparent beneficial result, as in our case. There is no evidence that the tumors decrease in size spontaneously.

SUMMARY

Mediastinal ganglioneuroma is a rare tumor although more will doubtless be discovered with the rapid progress of thoracic surgery. About 20 instances were collected prior to this report. We have been able to assemble more than 33 cases from the available literature. These are chronologically presented. The tumor consists of nerve cells embedded in a large amount of fibrillar stroma. It presents a low tendency toward malignancy, which varies inversely with the age of the patient. The only beneficial treatment appears to

be surgical removal. Roentgenotherapy is of no apparent benefit. The prognosis is good in operable cases, and depends to some extent upon the degree of differentiation.

A case is presented in which a large ganglioneuroma was successfully removed from a young woman, age 35, with recovery. After 20 months, there is no evidence of recurrence.

A CHRONOLOGIC BIBLIOGRAPHY PERTAINING TO MEDIASTINAL GANGLIONEUROMA

[1] Loretz, W.: Ein Fall von gangliösem Neurom (Gangliom). Virchows Arch. f. path. Anat., 49, 435, 1870.

[2] Borst, M.: Die Lehre von den Geschwülsten. Wiesbaden, J. F. Bergman, 1902, p. 241.

[3] von Rindfleisch: Case cited by Borst,[2] p. 242.

[4] Tschistowitsch Russk. Uratsch, 1908; Abstr. in den Deutsch. Medizinalztg. No. 18, 31, 319, 1910.

[5] Friedrich, J.: Ein Fall von Ganglioneurom des Sympathikus. Frankfurt Ztschr. f. Path., 10, 456, 1912.

[6] Rosenson, W.: Neoplasms of Mediastinum in Infancy and Childhood. Am. Jour. Dis. Child., 26, 411, 1923.

[7] Sauerbruch, F.: Necrosis of Lung Following Extirpation of Ganglioneuroma. München. med. Wchnschr., 70, 1011, August 3, 1923; Abstr. J.A.M.A., 81, 1400, October 20, 1923.

[8] Stout, A. P.: Ganglioneuroma of Cervical and Thoracic Sympathetic Ganglions. J.A.M.A., 82, 1770, May 31, 1924.

[9] Brunner, A.: Removal of Ganglioneuroma of Posterior Mediastinum. Arch. f. klin. Chir., 129, 364, 1924.

[10] Riggs, T. F., and Good, L. P.: Ganglioneuroma of Mediastinum Requiring Surgical Intervention for Relief of Obstructive Symptoms. Arch. Surg., 19, 309, 1929.

[11] Harvey, W. G.: Ganglioneuroma of Mediastinum in a Child, Aged 9. Lancet, 1, 405, February 22, 1930.

[12] Lazarovits, L.: Ganglioneuroma of Posterior Mediastinum. Gyógyászat., 70, 327, April 27, 1930.

[13] Jackson, C., and Babcock, W. W.: Intrathoracic Ganglioneuroma. South. Clin. North America, 11, 1231, December, 1931.

[14] Beretervide, J. J., Fazio, J. M., and Cardenau, J. B.: Ganglioneuroma of Mediastinum. Rev. Soc. de Méd. Int. y Soc. de Tisiol., 7, 71, March-May, 1931; also Prensa Méd. Argent., 18, 41, June 10, 1931.

[15] Ranzi, E.: Ganglioneuroma of Mediastinum. Wien. klin. Wchnschr., 44, 840, June 26, 1931.

[16] Griesbach, R.: Intrathoracic Ganglioneuroma, Ztschr. f. Tuberk., 65, 365, 1932.

[17] Bigler, J. A., and Hoyne, A.: Ganglioneuroma. Amer. Jour. Dis. Child., 43, 1552, 1932.

[18] Armand-Delille, P., Lestocquoy, C., and Garois, H.: Intrathoracic Ganglioneuroma of Sympathetic Origin, Bull. Soc. de Pédiat. de Paris, 30, 474, October, 1932.

[19] Bohrer, J. V., and Lincoln, E. M.: Ganglioneuroma of Chest in Children, Jour. Thoracic Surg., 3, 365, April, 1934.

[20] Sophian, L.: Mediastinal Ganglioneuroma, ANNALS OF SURGERY, 101, 837, March, 1935.

[21] Distefano, G.: Endothoracic Ganglioneuroma. Tumori, 9, 245, 1935.

[22] Calzolari, T.: Ganglioneuroma of Mediastinum; Four Cases. Ann. ital. di. chir., 14, 15, January, 1935.

[23] Žahourek, V.: Roentgen Diagnosis of Intrathoracic Neurogenic Tumors in Connection with a Case of Mediastinal Ganglioneuroma. Časop. lék. Česk., 75, 589, May 1, 1936.

[24] Dobrzaniecki, W., and Stankiewicz, S.: Sympathetic Origin of Ganglioneuroma of Neck and Anterior Mediastinum. Jour. de Chir., 48, 785, December, 1936.

[25] Lanari, E. L., Pardal, R., and Aquirre, J. A.: Intrathoracic Ganglioneuroma. Prensa Méd. Argent., 24, 2001, October 20, 1937.
[26] Aiker, A.: Unusual Endothoracic Tumor (Ganglioneuroma of Sympathetic). Röntgen Praxis, 10, 95, February, 1938.
[27] Magalhaes, A. A.: Intrathoracic Ganglioneuroma. Arch. Argent. de Pediat., 9, 275, September, 1938.
[28] Clarke, J. M.: Large Thoracic Ganglioneuroma. Australian and New Zealand Jour. Surg., 8, 199, October, 1938.
[29] Cabot, R. C.: Ganglioneuroma. New England Jour. Med., 219, 620, October 20, 1938.
[30] Allison, P. R., and Carmichel, R.: Mediastinal Ganglioneuroma. Brit. Jour. Surg., 27, 175, July, 1939.
[31] Cooley, L. E., and McNamara, F. P.: Intrathoracic Ganglioneuroma, Jour. Iowa Med. Soc., 30, 117, March, 1940.
[32] Scott, E., and Palmer, D. M.: Intrathoracic Sympatheticoblastomas. Am. Jour. Cancer, 16, 903, 1932.
[33] Odier: Cited by Wahl, H. R.[42]: Neuroblastomata. Jour. Med. Res., 30, 205, 1914.
[34] Virchow, R.: Die Krankhaften Geschwülste. Berlin, A. Hirschwald, 1863, Vol. 3.
[35] Marchand, F.: Beiträge zur Kenntnis der Glandula Carotica und der Nebennieren. Internat. Beitr. z. Wissenschaftl. Med., Festschr. f. R. Virchow, 1, 578, 1891.
[36] Wright, J. H.: Neurocytoma or Neuroblastoma: A Kind of Tumor Not Generally Recognized. Jour. Exper. Med., 12, 556, 1910.
[37] Kuntz, A.: Anatomic Nervous System. Philadelphia, Lea and Febiger, 1929.
[38] Bailey, P., and Cushing, H.: A Classification of Tumors of the Glioma Group. Philadelphia, J. B. Lippincott, 1926.
[39] Cushing, H., and Wolbach, S. B.: Transformation of a Malignant Paravertebral Sympathicoblastoma into a Benign Ganglioneuroma. Am. Jour. Path., 3, 203, 1927.
[40] McFarland, J., and Sappington, S. W.: A Ganglioneuroma in the Neck of a Child. Am. Jour. Path., 11, 429, 1935.
[41] Foot, N. C.: Histology of Tumors of the Peripheral Nerves. Arch. Path., 30, 772, September, 1940.
[42] Wahl, H. R.: Neuroblastomata. Jour. Med. Res., 30, 205, 1914.

DISCUSSION.—DR. JULIAN MOORE (Asheville, N. C.): Doctor Curtis has reported the successful removal of a ganglioneuroma from the mediastinum, and I think he and his patient are to be congratulated. I think it well to extend the discussion to all intrathoracic tumors. They are more frequent than is indicated in the literature, and while some are not amenable to removal, many are benign and can be removed. There is still confirmed pessimism among medical men about removal. Several years ago, I saw a patient who had been advised against having the tumor removed because it was doing no harm. The benign extrapulmonary tumor may embarrass the function of the heart, lungs or mediastinal structures. All are potentially malignant. They should be removed when first seen, provided there is no valid contraindication. When they grow to such size as to embarrass respiration or circulation, the chance of successful removal is diminished.

I would like to call attention to a few points in the question of diagnosis. Roentgenograms are helpful. Diagnostic pneumothorax will show whether the tumor is extrapulmonary or intrapulmonary. Bronchoscopy is helpful, only, in eliminating tumor of the large bronchi. In differentiating whether it is benign or malignant, a therapeutic test of roentgenotherapy is certainly helpful.

With regard to operation, I personally prefer to use cyclopropane or "closed ether" in preference to nitrous oxide-oxygen. In performing such operations with nitrous oxide and oxygen I have a feeling that I am run-

ning a race with anoxemia. With cyclopropane or "closed ether" anesthesia your patient does not suffer from anoxemia and you can take your time. One must use pressure anesthesia, but it is not necessary to use intratracheal, unless there is obstruction or unless there is a large amount of pus and secretion which must be aspirated.

I reported a case several years ago, and that patient is alive and well after ten years. The first one I saw operated upon was when I was at Ann Arbor. This patient had a ganglioneuroma, which was removed, and the patient died of mediastinal emphysema. A number of men advocate closing the wound tightly, but I always insert a catheter and apply suction for 24 or 48 hours, which I think guards against mediastinal emphysema and tension pneumothorax. It probably does increase the risk of infection, but I cannot forget the former experience, and the suction has proved very satisfactory in my hands.

ENDOCRINE STUDIES OF PATIENTS AFTER SUBTOTAL HYPOPHYSECTOMY*

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A SYSTEMATIC STUDY of endocrine function in patients who have had subtotal hypophysectomies has been made with the intention of directing substitution therapy in the larger group of patients who have had nonfunctioning tumors of the hypophysis, and of determining the necessity for further depressant therapy in those having hyperfunctioning pituitary adenomata. This was suggested by experience with patients after subtotal thyroidectomy, in whom a state of hypopthyroidism, of hypoparathyroidism, or rarely, persistent hyperthyroidism required continued supervision and treatment.

Disability in such patients may be due to (1) failing vision, the usual indication for operation; (2) cerebral damage in important neighboring hypothalamic areas; or (3) endocrine deficiency or excess. The symptoms of endocrine dysfunction, present before the operation, may continue postoperatively but should be susceptible of correction. However, an important condition modifies the results of endocrine therapy. If the pituitary deficiency is so pronounced that its tropic influence on the subsidiary glands is entirely lacking, the injection of pituitary extract is ineffective. On the contrary when less serious pituitary deficiency exists, as in mild Fröhlich's disease, the injection of pituitary extract may develop the target organ, make it more sensitive to pituitary hormones, and thus it is more effective. In many cases the postoperative pituitary remnant is not able to supply sufficient hormone to maintain the secondary gland. Furthermore, the deficiency has often been present for years and the atrophy of the receptive organ may be so great that it does not respond to extract injections. Hence it would seem that the object of endocrine therapy, in these cases, should be to supply the hormones of the glands which the pituitary normally maintains; that is, the thyroid, the adrenal, and the gonad.

In addition to the usual complete clinical examination the following plan of study was carried out: (1) The basal metabolic rate was determined. It has been found in animals that total hypophysectomy of the normal animal leads to a metabolic rate 25 per cent less than average normal. In addition, if thyroid atrophy occurs, the metabolic level will fall to that of athyreosis. (2) The blood cholesterol was also determined. Hypopituitarism is characterized by normal or subnormal levels, but if hypothyroidism is superimposed the blood cholesterol will rise. (3) The condition of the adrenal

* Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

cortical function in our patients was determined by the Wilder test because the adrenal cortex is maintained by the tropic action of a pituitary factor. For this test, the ingestion of sodium is reduced in the diet to a known low level and the potassium is raised by foods selected; the addition of potassium citrate over a period of two days and four hours, and the water intake, is prescribed according to the patient's weight.. Under these conditions the normal adrenal cortical function will restrict the loss of sodium and chloride in the urine, but in adrenal deficiency the sodium and chloride concentration of the urine in the last period of the test becomes elevated. Comparison of many other substances in the blood and urine indicates that among all these the concentration of chloride in the urine, in the four hours after the two days' dietary preparation, is the most significant for the establishment of adrenal cortical function. This test, of course, demonstrates only the electrolytic controlling function of the adrenal glands and does not determine, directly, the carbohydrate controlling function. The normal values found for the chloride concentration of the urine in the terminal four-hour sample fall below 125 mg. per 100 cc. of urine; values between 125 and 225 mg. may occur in normal persons or in those having adrenal insufficiency; values above 225 of chloride ion in milligrams per cent occur only in patients with adrenal cortical insufficiency. The sodium loss is adequately represented by the chloride determination. This test, then, is an extremely simple and valuable one, which requires only dietary control for 52 hours and a chloride titration in the urine. Except for the time involved, it is the simplest of all the endocrine assay tests. Its introduction now allows us to determine the function of one of the major glands that has hitherto been neglected in much endocrine analysis.

(4) Carbohydrate balance, involving as it does the diabetogenic function of the pituitary, the responsiveness of the adrenal cortex to that hormone, the state of the liver as influenced by the thyroid, and the activity of the insulin-producing organ, was studied as usual by the glucose tolerance and insulin tolerance tests. One hundred grams of glucose was the test dose in the former, with capillary blood-sugar determinations made before, and one-half, one, two and three hours after ingestion of the sugar. Ten units of plain insulin were given in the latter, with similarly distributed blood-sugar determinations.

(5) The gonadotropic function of the pituitary was estimated by the history of amenorrhea and loss of sexual activity, combined with the physical examination of the sexual organs to determine the degree of atrophy. In some cases the vaginal epithelium was studied for evidence of estrogenic activity according to the morphology of the cells and their straining characteristics, after the method of Papanicalao. (6) Parathyroid function was observed by determination of the blood calcium and phosphate and a study of bone roentgenograms. In one case, hyperparathyroidism was discovered and titration of urinary calcium was carried out.

As is usual in such a series, the number of patients with hypopituitarism

was three-fourths of the whole number, in this instance, 18 of 25. In all instances, these patients had hypopituitarism before operation, occasionally with cerebral damage accompanying the visual disturbance. The hypopituitarism continued after operation; the nervous disorder was in some instances improved but in other instances increased; the visual loss was usually arrested or relieved, but several patients developed blindness some years after operation.

These 18 patients may be divided into three groups: First, those with severe hypopituitarism, with resultant total disability, with more or less cerebral damage, and loss of visual acuity; second, those with endocrine deficiency and moderate disability; and third, a group with slight endocrine deficiency and relatively little incapacity. There are seven patients in the first group, four in the second, and seven in the third. The case history of a patient illustrating the first group is as follows:

Case 1.—G. D., male, age 60 in 1940. At the age of 44, progressive loss of vision began, affecting the left eye more than the right; sudden, unexplained obesity, loss of body hair, loss of libido, and extreme drowsiness developed. He was given four roentgen ray treatments at another clinic, with arrest of the process for five years. Loss of vision in the right eye then began, and surgical removal of the tumor was advised. Until the onset of this disease at age 44, he had been in normal health. He has two grown sons.

At the time of operation, when the patient was 51 years of age, he was tall and slender. He had a very scanty, soft beard which required shaving only twice a week. There was absence of hair on the chest, axillae, arms and legs and pubis, and he was wholly devoid of eyebrows. The left eye was completely blind. There was a small visual field in the nasal half of the right eye. Both optic nerves were extremely pale and showed a very definite primary optic atrophy. The sella turcica was very large, and ballooned out. The posterior clinoid processes were so thin that they were represented by fine shadows.

At operation, a purplish, bulging mass, which occupied the sella and extended forward beneath the chiasm between the optic nerves, was found. The contents of the mass were removed and, on microscopic examination, proved to be a pituitary chromophobe adenoma. His chief complaint at the time of discharge from the hospital, December, 1931, was impairment of vision. This, however, soon began to improve. He was unsteady in gait and became quickly exhausted; occasionally, he was troubled with episodes of nausea. His condition remained unchanged until October, 1938, when a cerebral accident occurred which resulted in a right hemiparesis, loss of sphincter control, and hyperthermia. He survived this but was bed-ridden until his death in March, 1940.

An endocrine study, in 1939, indicated hypometabolism, with a basal metabolic rate of —23 per cent, but relative thyroid sufficiency in proportion to the lowered demand of the general severe hypopituitary state, since the blood cholesterol was normal—202 mg. per 100 cc. of blood. The adrenal condition was one of deficiency, as indicated by muscular weakness and a blood pressure of 108/80. Three Wilder tests were elevated, giving final chloride concentrations of 280, 410 and 190 mg. per cent of urine. Carbohydrate metabolism was sluggish. The sugar tolerance could not be made because of vomiting, but a similar patient (Mr. C. E.) had a sugar tolerance as follows: Fasting blood sugar, 75; one-half hour after 100 Gm. of glucose by mouth, blood sugar, 104; after one hour, 80; after two hours, 116; after three hours, 105—showing an absence of alimentary hyperglycemia. The insulin tolerance, as is usual in such cases, indicated marked sensitivity to insulin, with a fasting blood sugar of 106 which, upon the administration of ten units of plain insulin, dropped to 42 mg. per 100 cc. of blood in two hours. The

gonadotropic function of the pituitary was absent as indicated by absence of sexual urge, absence of hair, and atrophic primary and secondary gonads.

A second patient of the same type, operated upon November 25, 1938, further illustrates this first group.

Case 2.—Until 27 years of age this patient (Mr. L. H.) was an active, alert clerk in a hardware store. He was married and had two children. In the summer of 1930, a box of hardware fell on his head as he was pulling another box out from under it. The blow dazed him momentarily but did not knock him down or cause any laceration. After this incident he began to feel weak and to have difficulty in remembering the whereabouts of articles in the store. Loss of libido and impotence were noted during the next year. Two years later, that is, at age 30, he was under treatment by a reputable physician for six months because of weakness and colonic irrigations, and iron and arsenic were given without benefit. At age 31, he was a patient at an excellent hospital where treatment for anemia was given. While in the hospital, he began to suffer from headaches which were frontal and diffuse, accentuated by severe spasms of pain lasting a few seconds. At age 31, loss of beard growth, and loss of hair on the chest and arms began, and at the time of operation he had no hair in these areas, whereas at one time he had a thick growth. At this same age, failing vision occurred and, finally, the true nature of his difficulty was recognized. Roentgenotherapy was administered over a two-year period, with only temporary relief. At age 35, he entered the hospital complaining of weakness, fatigue, lethargy; loss of sexual urge and potency; loss of facial and body hair; unexplained obesity; variable headaches; loss of vision; polyuria and polydypsia.

Roentgenograms showed a large, distorted sella, with a shadow of suprasellar calcification. A cystic craniopharyngioma was found at operation, and this was evacuated. Postoperative recovery was good; vision was retained and the headaches relieved. Very rare sexual activity occurred after an absence of eight years, but somnolence and marked weakness continued. Approximately one year after operation (1939) evidences of cerebral pathology became manifest; convulsions and hemiparesis have occurred and, at present, the patient is completely disabled.

Endocrine study showed extreme glandular deficiency; the basal metabolic rate was —40 per cent, the blood cholesterol 392, the Wilder test 380; the sugar-tolerance test curve was flat; insulin sensitivity marked; libido was very slight; and the testicles and prostate were atrophic. Hence, deficiency of thyrotropic, adrenotropic, and gonadotropic hormones was indicated. In this patient, the large cystic craniopharyngioma had evidently damaged the adjacent brain structures irreparably and destroyed the pituitary gland by pressure.

The remaining patients in this and succeeding groups are much less discouraging because injury to the brain was less severe and endocrine deficiency less extreme. There is, however, a group of patients partially disabled. This type may be illustrated by the case of Miss M. H.

Case 3.—This patient entered the hospital at age 53. She had had a premature spontaneous menopause at age 28. At age 43, a period of headaches and pain in the right eye had occurred. A diagnosis of hypothyroidism was made, although, doubtless, pituitary disease could have been diagnosed at that time. These symptoms subsided. On admission to the hospital, two years later (1934), she complained of failing vision for two months; somnolence; unsteady gait and uncinate fits. A left homonymous hemianopsia was present.

Roentgenograms showed an enormous sella turcica. At operation, the right optic nerve was found to be tightly stretched over a purple tumor mass that lay between the two nerves and beneath the chiasma. The capsule was opened and adenomatous tissue removed by curet until the tumor collapsed. Recovery was uneventful—with enlarge-

ment of the visual fields. The patient did not return to her former occupation because she did not feel strong enough. She has been very much inclined to forget things and has been unable to recall events that happened prior to the operation.

At the time of our endocrine study, five years after operation (1939), she presented the picture of moderate obesity, in a pleasant, cooperative woman, age 58. She carried on a normal but limited home life. The blood pressure was 148/78, pulse 68, temperature normal. The hair was normal and the skin smooth. The eyes reacted to light and accommodation. The thyroid was palpable but not nodular. Pelvic examination showed slight atrophy of the vaginal epithelium and a small uterus.

Endocrine studies indicated hypometabolism—a basal metabolic rate of —18 per cent and blood cholesterol of 324 demonstrated hypothyroidism. The Wilder test was normal (70 mg. per cent); the sugar tolerance test was low; there was marked sensitivity to insulin; the blood sugar dropped from 78 to 43 in one hour, and signs of hypoglycemic shock occurred. Gonadotropic function was absent. She has been benefited by small doses of thyroid.

As an example of a still more favorable course, the case of Mr. H. E. may be presented.

Case 4.—The patient is now age 52, and is a salesman in a department store. actively at work. He is married and has two children; the younger was born when he was age 34. The following year, while playing tennis, he suddenly discovered that his left eye was totally blind; this persisted for two or three days, after which the blindness was confined to the temporal field of the left eye. This condition remained without notable change until he was age 38. Sexual impotency began approximately at the same time as the amblyopia. At age 38, he experienced severe, constant headache for a period of about ten days; he then noticed that he was unable to see traffic lights or to read any part of a newspaper other than the headlines. He consulted an "eye doctor" who prescribed rest for the eyes for a few days. From then, until age 45, he read only with the help of a magnifying glass. Late in his forty-fourth year he consulted a doctor in Chicago about his eyes, was told that he had syphilis, and was given a course of neoarsphenamine. After some treatment he had arsenical poisoning; his hair fell out, he had a high temperature, and his skin desquamated. Meanwhile the sight in both eyes became steadily worse. Finally, he had a series of severe headaches which continued for two weeks until one morning he awoke completely blind.

Roentgenograms showed marked distention of the sella, with erosion of the posterior clinoid processes and floor. Visual fields showed blindness of the left eye and a small nasal field of vision in the right eye.

At operation (1933), the right optic nerve was found to be tightly stretched and thinned-out over the surface of a large, purple, dome-shaped tumor mass in front of the chiasm. The contents of the tumor were a dark chocolate-brown fluid and a small amount of soft degenerated adenomatous tissue. This was removed completely, so that the chiasm and nerves hung loosely in the field. The tumor was a chromophobe adenoma which had had hemorrhage into it or had undergone degeneration. The patient made a good postoperative recovery, and has been working ever since—a period of seven years. Vision has not returned to the left eye, but the nasal field of the right eye is maintained.

Endocrine study, six years after operation (1939), gave the following results: Basal metabolism was within normal range (—14 per cent). There was evidence of slight hypothyroidism, that is, the blood cholesterol was 282 (normal upper limit 240 mg. per cent). An interesting finding, on a single determination, was a very high Wilder test —568 mg. per 100 cc. of urine; this did not fit in with his clinical condition, although his blood pressure was low normal (108/78). Sugar tolerance was normal and insulin sensitivity was absent. Gonad atrophy and absence of activity indicated lack of gonadotropic function.

This man was extremely fortunate that the long neglect and incorrect diagnosis of his condition was associated with a tumor that did not destroy all pituitary function and did not injure the brain, although three-fourths of the visual field had been lost.

The least damaged patient in this series is Mr. A. L.

Case 5.—The patient is an active business executive who, at age 46, experienced loss of libido. During the following year he noted fatigue and, finally, six months before operation, diminution of visual fields. The correct diagnosis was made at this time. Nine roentgen ray treatments were administered soon after the visual loss was discovered, at another hospital. There was temporary improvement, but two months later, sudden, marked limitation of vision occurred and he immediately presented himself for operation. Roentgenograms showed an enlarged sella, with an eroded floor. The visual fields displayed a bitemporal hemianopsia.

At operation (1937), curettage of a large hemorrhagic and partly degenerated tumor relieved the pressure on the optic nerve. He has since returned to work and has recovered vision and sexual activity. It is now three years since operation.

Endocrine studies, made last year (1939), found slight hypometabolism with normal thyroid function, as indicated by a blood cholesterol level of 234 mg. per cent; normal adrenal cortical activity; Wilder test 70 mg. per cent; normal sugar tolerance; absence of insulin sensitivity; and a normal condition of the genitalia and sex activity.

Of the seven patients with hyperpituitarism, none has developed hypopituitarism postoperatively; three have persistent hyperpituitarism, two of these, with manifest hyperthyroidism, diabetes and hypertension. All of this group, clinically, had acromegaly. In the three disabled patients, acromegaly was severe before operation; in the four well-adjusted patients, the development of acromegaly was slight.

As an illustration of mild hyperpituitarism the case of Mr. A. L. may be given.

Case 6.—The patient is a working man, age 36, who had an obvious and progressive acromegaly for ten years, but no disability until eight months prior to operation when severe headaches began. There was no loss of the visual fields but roentgenograms revealed a very large sella turcica. Preoperatively, there was no diminution of sexual function or loss of secondary sex characteristics. The preoperative metabolic rate was +9 per cent, and the blood-sugar level was high.

At operation (1938), there was no evidence of pressure on the optic nerves, and the tumor was small and inaccessible; only a small portion was removed. He made a good recovery, and returned to work, but has continued to have mild headaches. Several epileptiform seizures have occurred but these are controlled by bromides.

Endocrine studies, a year postoperatively (1939), showed hypermetabolism (basal metabolic rate +20 per cent), but normal blood cholesterol (244 mg. per cent) indicated normal thyroid functions. This deduction is permissible in view of the fact that the sugar tolerance curve was normal, that is, diabetes which might raise the blood cholesterol was absent. Adrenal function was normal, as indicated by a Wilder test result of 110 mg. per cent of urine. There was no insulin sensitivity. Gonadotropic function was normal as shown by sex activity and normal genitalia.

Mrs. F. H. illustrates the persistent form of hyperpituitarism.

Case 7.—The patient entered the hospital, at age 35, complaining of failing eyesight for two years; acromegalic changes in the face, hands, and feet for six years, premature

menopause and increased weight. At the same time, she had severe pain in her face and tongue, which occurred intermittently and lasted for several hours to one or two days and was not relieved by drugs. She had had no pain for two years prior to admission to the hospital. She had had occasional night sweats and had lost strength; she had stopped menstruating two years before. She had had severe headaches which stopped following roentgenotherapy of the pituitary.

Examination revealed a typical acromegalic woman, age 35. She was intelligent, rational, cooperative, oriented, and had a good memory for past and recent events. There was no ataxia, dysmetria, or loss of association of any muscle movements of the entire body. The visual fields showed a bitemporal hemianopsia, with contracted binasal fields; both disks were paler than normal and the margins were not sharply demarcated; the vessels were not engorged and there was no elevation of the disks. The head was long, with a prominent occiput; the skin of the face was rough, dry, and covered with blotchy markings. The nose was very large and the lower jaw protruded and was greatly enlarged. The tongue was large and filled the mouth more than in the average individual. The neck was full but symmetrical, and the thyroid was palpably enlarged and firm. The blood pressure was 154/96. The hair on the arms and legs seemed increased, and resembled that of a male. The hands and feet were very wide and thickened; the fingers and toes were enlarged and clubbed, and all of the joints of the extremities were enlarged. The patient had had a normal pregnancy five years before.

Roentgenograms of the skull showed a greatly enlarged sella turcica, with the posterior clinoid processes practically destroyed. The basal metabolic rate prior to operation was +17 per cent.

At operation (1932), the right optic nerve was found to be flattened out over a purple-domed tumor mass which pushed upward directly against the chiasm and did not extend forward between the optic nerves; the left nerve was likewise very flat. The dome of the tumor mass was incised, and immediately a large amount of soft, degenerated tumor material, together with dark yellow fluid, escaped. The tumor capsule collapsed and fell away from the chiasm. With the sucker and a curet, the tumor tissue was removed and the capsule was coagulated with the electrosurgical unit. The optic nerves and chiasm were thus freed from pressure.

The patient made an excellent postoperative recovery, and when dismissed from the hospital the fields of vision had enlarged remarkably. About two months later she began to menstruate again, and a year and a half later (1934) was delivered of a normal baby boy. After the child was born, menses resumed and continued regularly for two years, although the flow was scant; menstruation finally stopped again at age 39. For several months following operation Mrs. H. noticed that the size of her hands regressed considerably; previously she had been unable to fold her hands together because of the thickness of the fingers. She continued to be active and feel well for four years.

Three years ago (1937), five years postoperatively, symptoms of hyperthyroidism, hypertensive heart disease, and diabetes gradually became worse and cardiac failure occurred.

The endocrine findings were as follows: in 1939, seven years after operation: Hypermetabolism (basal metabolic rate +52 to +27 per cent); blood cholesterol elevated (276 mg. per cent); Wilder test normal; (60 mg. chloride per 100 cc.) of urine. This throws no light on hyperactivity of the adrenal cortex. The blood pressure has steadily risen from the nearly normal preoperative level to that of malignant hypertension. Cardiac hypertrophy, coronary insufficiency and congestive failure are in progress. It may be suggested that this is evidence of hyperfunction of the adrenal cortex. Sugar tolerance test found prolonged hyperglycemia indicative of pituitary diabetogenic activity (fasting blood sugar, 119, one-half hour, 216, one hour, 298, two hours, 292 and three hours, 172). Insulin tolerance did show some sensitivity; the blood sugar dropped from 120 to 75 mg. per 100 cc. of blood in three hours after ten units of plain insulin was given. Gonadotropic function was undetermined because the

amenorrhea at this time is probably the normal menopause usually associated with hyperactivity of the pituitary. Since the recrudescence of hyperpituitarism corresponds with the menopause it may well be due to the withdrawal of the opposition that the ovary normally has for the pituitary.

In the hypopituitary group (Table I), hypometabolism is the rule; four are extremely low, between —30 and —40 per cent; 11 are in the neighborhood of —20 per cent; this is the level usually found in hypophysectomized animals, and two are near the zero per cent level. The blood cholesterol is significantly raised in all four patients with the lowest rates, indicating thyroid deficiency; however, in only six of the larger group, at —20 per cent, is it elevated, while in the remaining five it is normal, indicating that in these cases the hypometabolism is not associated with relative hypothyroidism. Thyroid administration would be of value in ten of these 17 patients, to judge by hypercholesterolemia.

Adrenal insufficiency was indicated by abnormally high chloride concentration in the urine at the termination of the Wilder tests, in five of the hypopituitary patients, as shown in Table I, and in one of the hyperpituitary group, as shown in Table II. Oddly, the two patients with the highest tests (as high as any found in fully developed Addison's disease) are in excellent clinical condition, carrying on normal lives. This suggests that in some way the hypopituitary state, under the usual conditions of life of these patients, avoids the sodium depletion of the body that leads to the crises which occur in patients with Addison's disease. The depletion is demonstrated by the Wilder test, but probably does not occur under ordinary conditions.

Consideration of the sugar tolerance curves brings out the expected lower curves; that is, greater tolerance to sugar in the hypopituitary group, but under the conditions present the flatness is rarely pronounced and the curves usually are entirely normal. Hence this test, in such cases, would rarely be of diagnostic value in establishing the hypopituitarism which is certainly present. The hyperpituitary cases, on the contrary, have a higher curve, that is, lower tolerance to sugar. This was most pronounced, of course, in the two patients with active acromegaly. Five of these seven patients have sugar tolerance curves that are abnormally high.

The insulin tolerance curves also brought out a distinct difference between the more and less deficient hypopituitary cases and the hyperpituitary cases. As was expected, the more hypopituitary patients had greater susceptibility to insulin. However, two of these patients maintained the blood sugar unchanged throughout the test. In the hyperpituitary group, three of the seven cases were unaffected by the insulin. One of these patients, however, had a marked insulin effect in combination with a high sugar tolerance curve.

Sexual function and the condition of the sex organs indicated great deficiency in all of the hypopituitary cases except three. In these, normal gonadal development and function were maintained. In the hyperpituitary group two were normal; two women, in addition, had amenorrhea and hot

TABLE I

PATIENTS WITH HYPOPITUITARISM

Patient*	B M.R.	Blood Cholesterol	Wilder Adrenal Test	Sugar Tolerance F	½	1	2	3	Insulin Tolerance F	½	1	2	3	Gonad. Libido	Blood Cal.	Blood Phos.	Operation	Clinical Condition
Mr. G. D.	−23	202	310	Vomited					106	71	67	42	44	Small Absent	..	..	12/14/31	Death 3/40
Mr. D. C.	−34	321	64	84	148	217	131	168	90	..	..	..	..	Small Absent	..	2 9	None	Mental deterioration
Mr. H. R.	−22	316	100	..	..	..	..	..	68	47	55	51	45	Infantile	10 6	4 1	1926 (Cushing)	Blind; mentally normal; severe physiologic deficiency
Miss S. W.	−33	303	60	..	155	120	108	112	88	..	52	..	50	Infantile	..	4 0	Mayo Clinic	Cerebral pathology; severe physiologic deficiency
Mr. J. S.	−26	320	50	80	136	185	95	91	77	63	50	shock		Infantile	..	..	None	Mental deterioration; physical deficiency; death 7/24/40
Mr. L. H.	−40	392	380	75	129	103	98	83	73	42	42	41	31	Small Diminished	10 5	4 5	11/25/38	Mental deterioration; physical deficiency; death 8/40
Mr. C. E.	− 6	199	50	75	104	80	116	105	70	59	53	59	59	Small Diminished	11 2	3 4	12/ 2/31	Physiologic deficiency; blind
Mr. C. L.	−30	284	190	106	150	74	113	120	74	72	86	107	47	Small Diminished	9 9	5 0	4/22/27	Physiologic deficiency; death 8/25/39
Mrs. C. P.	−21	189	76	Vomited					105	..	..	..	58	Atrophy Amenorrhea	8 9	2.6	11/27/28	Slight mental deterioration; housework; bitemporal hemianopsia
Miss M. H.	−18	324	70	60	121	104	99	119	78	54	43	shock		Atrophy Amenorrhea	10 5	3 3	5/ 2/34	Uncinate fits; moderate physiologic deficiency; housework
Mrs. G. McD.	−19	306	50	92	148	222	151	137	130	95	75	50	50	Hysterectomy	..	..	1/ 8/38	Mild physiologic deficiency; ambulatory; housework
Mr. R. W.	−15	286	220	114	167	112	132	70	66	47	43	42	37	Atrophy Absent	10 4	4 3	1/23/33	Mild physiologic deficiency; ambulatory; not working
Mr. H. E.	−14	282	568	87	154	125	90	84	71	73	67	67	70	Small Absent	9 8	3 0	5/31/33	Mild physiologic deficiency; working in store
Mrs. M. O.	−18	312	..	89	123	94	103	93	89	66	44	53	50	Atrophy Amenorrhea	9 9	4 4	1/22/34	Mild physiologic deficiency; housework
Mrs. M. S.	−20	239	50	84	177	97	122	99	88	80	67	33	61	Infantile Amenorrhea	10.7	3 4	9/11/31	Mild physiologic deficiency; housework
Mrs. S. S.	+ 4	206	60	83	200	184	190	126	93	90	79	68	56	Menses Normal	10 8	3 4	4/15/27 4/22/36	Headaches; mild physiologic deficiency; housework
Mr. I. S.	−21	215	428	80	164	178	96	125	89	77	73	75	70	Normal Diminished	10.9	3 1	10/16/30	Normal business work—salesman
Mr. A. L.	−21	234	70	86	151	130	115	111	83	74	..	..	85	Normal	10 8	4 0	6/28/37	Normal business executive

* Order of patients is graduated according to the estimation of their clinical condition; the worst at the top. B.M.R. on Aub-Dubois standard; blood cholesterol mg. per 100 cc. of blood. Wilder adrenal test, the mg. NaCl per 100 cc. of final four-hour urine specimen; sugar tolerance on capillary blood after 100 Gm. of glucose; insulin tolerance on capillary blood after ten units of plain insulin.

TABLE II

PATIENTS WITH HYPERPITUITARISM

Patient*	B.M.R.	Blood Cholesterol	Wilder Adrenal Test	Sugar Tolerance F	½	1	2	3	Insulin Tolerance F	½	1	2	3	Gonad. Libido	Blood Cal.	Phos.	Operation	Date of Examination	Clinical Condition
Mrs. R. H.	+28	382	70	226	266	260	408	444	104	114	129	..	..	Atrophy Hot flashes	11.6	5.8	None 1276 r units	6/40	Hypertension, hyperthyroidism, and diabetes
									Himsworth I+S										
Mrs. F. H.	+27	276	60	119	216	298	292	170	120	..	..	..	75	Small Amenorrhea	10.1	2.7	1/25/32	2/40	Full-term pregnancy postop. Hypertension, hyperthyroidism, and diabetes
Mr. E. F.	+15	202	236	137	276	286	154	167	102	83	65	67	42	Atrophy Impotence	Bone pathology		None		Weakness, severe functional deficiency
Mrs. M. S	− 8	335	144	86	253	160	173	117	82	93	80	79	78	Amenorrhea Hot flashes	10.5	4.11	3/ 2/26	7/39	Headache, mild functional deficiency, housework
Mr. A. L.	+20	244	110	104	152	194	119	75	110	81	79	74	100	Normal	10.7	4.7	6/17/38	6/40	Controlled epilepsy, working as laborer
Mrs. R. C.	− 1	248	68	111	200	222	143	111	115	125	132	102	117	Normal	10.2	3.9	None	1/40	Mild hypertension, active life
Mrs. W. S. Preop.	− 9	..	74	92	214	184	121	95	88	90	96	76	71	Oligomenorrhea	..	..	1/22/40		
Mrs. W. S.	−19	246	60	80	126	201	114	131	85	76	77	52	62	Atrophy Amenorrhea	10.7	2.8		7/40	Normal home life and previous occupation

* Patients with *acromegaly* arranged in order of the severity of their clinical condition. Mrs. R. H., and Mrs. F. H. have persistent hyperpituitarism. Mr. E. F., and Mrs. M. S. are partially disabled. Mr. A. L., Mrs. R. C., and Mrs. W. S. are not incapacitated.

flashes, indicative of pituitary activity characteristic of the menopause; one male of the seven had impotence and atrophy similar to that of the deficiency group.

Our experience indicates that the diagnosis of hyperpituitarism, associated with nonfunctioning pituitary or embryonal tumors, is frequently missed. These tumors often produce irreparable cerebral damage and frequently extreme pituitary atrophy. The diagnosis would be made earlier if patients presenting signs of loss of sexual function and secondary sex characteristics were studied with this in mind. In women, amenorrhea and obesity are early results; in men, loss of libido and diminished beard growth occur in the incipient stage.

If cerebral damage is great, restoration of the patient is unlikely; if pituitary function is completely destroyed, substitution therapy is not successful.

Endocrine studies emphasize the loss of individual pituitary functions. These may be replaced by administration of the hormones of the glands normally maintained by pituitary activity; this is especially true of the thyroid. Thyroid therapy, while indicated and valuable, should be carried out cautiously. The objective should be the maintenance of a metabolic level correlated to the total functional state of the hypopituitary organism. This is at —20 per cent; that is, thyroid substitution should maintain normal metabolic processes at that level. Increasing the rate above this will place the hypopituitary patient in a state of relative hyperthyroidism, detrimental to other physiologic factors.

Hyperpituitarism may continue after operation and be difficult to control, or the acromegalic process may cease. The persisting disability may be due to hyperfunction of the subsidiary glands. The problem becomes one of controlling hyperthyroidism, diabetes and hypertension. If this does not occur, that is, if treatment successfully stops the hyperpituitarism, the result is satisfactory, and the energy production of the body and sexual function become adequate.

DISCUSSION.—DR. WALTMAN WALTERS (Rochester, Minn.): If the neurologic surgeons and those interested in neurology are not going to discuss Doctor Davis' paper I would like to do so. It seems to me that Doctor Davis' paper and the discussion of Dr. George Curtis, given this morning, on hyperfunction of the thyroid gland, indicates the present trend of surgical investigation.

Those who have been interested in surgical lesions of the ductless glands have been impressed by the frequency with which hyperfunctioning adenomata are absent in cases in which the clinical picture is one of hyperfunction of some gland. We are, therefore, often at a loss to explain why the clinical picture of hyperfunction of some particular gland is present, especially when, at operation, the gland in question appears to be normal. In our experience, less than 50 per cent of patients who present the clinical picture associated with hyperfunction of the cortex of the suprarenal gland are found to have hyperfunctioning adenomata at operation. In that group of cases of paroxysmal

hypoglycemia in which hyperfunctioning adenomata of the islands of Langerhans are suspected, such tumors have been found in less than 50 per cent.

What is the explanation, and what are we going to do? It seems that by testing the function of the ductless glands prior to, or subsequent to, hypophysectomy, as Doctor Davis has done, data may be obtained which may assist in determining the cases in which the hypophysis is the disturbing factor and influences the action of the ductless glands.

I attended the meeting of the Central Society for Clinical Research recently. These men are as interested in surgical problems as we should be in medical problems, because they complement each other. Our functional study of the ductless glands is now in about the same phase as were studies of renal function in 1919. I believe the cooperation of internist and the surgeon will open these fields so that we, as surgeons, will be able to reach a better decision as to whether or not patients with lesions of the ductless glands should be subjected to operation. I believe Doctor Davis' statistics will serve as an example of the trend in surgical investigation of the future.

DR. EMIL NOVAK (Baltimore, Md.): Doctor Walters has apologized for discussing the studies of a neurologic surgeon, and surely a gynecologist should offer an even greater apology. And yet, many of the subjects discussed by Doctor Davis are encountered in the daily work of the gynecologist. A good example is the rather vaguely defined group of cases comprised under the designation of hypopituitarism, of which the adiposogenital dystrophy of Fröhlich is the most common type. The gynecologist encounters all sorts of variations of hypopituitarism. In the classic Fröhlich type, the patient presents a characteristically disturbed obesity, she is amenorrheic, and the uterus is hypoplastic. But we also see patients with exactly the same sort of obesity, who menstruate normally and bear many children. On the other hand, in certain cases of hypopituitary amenorrhea there is no obesity. Finally, either with or without obesity or amenorrhea we may or may not see disturbances of water balance, characterized by such phenomena as menstrual or periodic edema. My observation has been that in the Fröhlich cases the basal metabolic rate is within normal limits, though occasionally it may be slightly subnormal.

Recent investigations have shown that the metabolic disturbances of the Fröhlich syndrome have their source, not in the pituitary, but in the parapituitary areas of the midbrain, probably in the hypothalamus. This was suggested by the observations of Cushing and Teel, many years ago, as to the effects of tumors located in this area.

Doctor Davis spoke of substitution therapy for cases of this general type, but I am sure he appreciates the inadequacy of present-day substitution treatment for this indication. Thyroid is, of course, of value if there is an hypothyroidism, but this is not the usual rule. The pituitary hormones have not been isolated, we know nothing of their chemical structures, and we have no pituitary sex hormone preparations of established clinical effectiveness. In the case of the ovary, by contrast, the hormones have been isolated, we know their exact chemical composition, they can be prepared in crystalline form and we know much of their physiologic actions, so that they can be handled like the better understood drugs.

All this, however, does not detract from the importance of Doctor Davis' study, which represents a laudable effort to study a large group of pituitary cases from the standpoint of their physiologic and biologic connotations.

DR. AMBROSE STORCK (New Orleans, La.): Doctor Davis' reference to the influence of the pituitary on the thyroid brings to mind something we

have been doing for patients with hyperthyroidism who do not respond satisfactorily to the usual preoperative preparation. Because estrogenic hormones inhibit the production of thyrotropic pituitary hormone, diethystilbestrol or other estrogenic substances have been given to a small number of cases which could not be brought into good condition by means of rest, calcium, iodine, a high caloric diet and vitamins. The number of cases in which we have observed apparently beneficial effects following this type of therapy is still very small, but the results so far have been at least encouraging.

DR. LOYAL DAVIS (Chicago, closing): I am very grateful for this discussion. It was the inadequacy of substitution therapy in many people that led us to attempt to determine, if possible, which one of the glands might be at fault. We found in many cases that substitution of thyroid helped immediately, and in other cases it did not. Theelin did more for one patient than any other type of therapy. It is the entire problem of substitution therapy that we are trying to investigate.

PERFORATED PEPTIC ULCER*

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and
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This report is an analysis of 111 consecutive cases of perforated peptic ulcer admitted to the Louisville City Hospital, from 1931 to 1940, with a description of our present treatment. The importance of the streptococcus in relation to mortality is stressed, and the local implantation of sulfanilamide is advocated. No comparison with statistics from elsewhere is attempted.

These patients were all charity patients from the low income group. There were 107 males and four females; 82 white and 29 colored. Corrected for the larger number of white patients admitted to the hospital, there was a ratio of white to colored of 4:3. Using the conventional grouping of months for the seasons, there were 37 cases in the Spring, 28 in the Fall, 24 in Summer, and 22 in Winter. The ages ranged from 18 to 73 years, with a median of 37.

There was no history of previous indigestion in 12 cases. In the others, ulcer symptoms had existed from three days to 30 years, with a median of four years. Four patients had had ulcer symptoms two, three, 11 and 12 years before, and then were symptom-free until perforation. One patient had been operated upon elsewhere for a perforation three years before we saw him. Another was operated upon twice by us for perforation, with an interval of two years. Sixty-one patients had employed alkalies, frequent feedings or both for the relief of symptoms, and 18 had been exposed to active medical treatment at some time or other. Three patients were on an active Sippy regimen, with subjective relief, at the time of perforation.

Definite increase of symptoms, three to 10 days before perforation, occurred in 68 per cent. Alcohol, particularly in the form of beer, seemed to be the precipitating factor in 11 patients. Perforation occurred during sleep (five patients), at work, on an empty stomach, and after meals. Only 65 per cent had vomited after perforation, and then usually only once or twice.

The temperature on admission varied from 96.5° to 103° F., averaging 98.8°; 55 per cent having a slightly subnormal temperature. The pulse rate averaged 94, and respirations 26 per minute. The average admission blood pressure was 129/79, only three patients being in shock, as indicated by blood pressure. Two of these were moribund and died within two hours

*Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

after admission. The small incidence of shock is emphasized, because of the general impression that shock is characteristic of perforated ulcer. The presence of pallor, and cold, clammy skin has caused many examiners to write "patient in shock," while recording a blood pressure of 120/80, with a pulse of 80. The fact that shock may, however, be imminent and easily precipitated, is shown by three patients in this series who suffered severe vascular collapse as the result of spinal anesthesia. Blood concentration studies would be of interest in this connection.

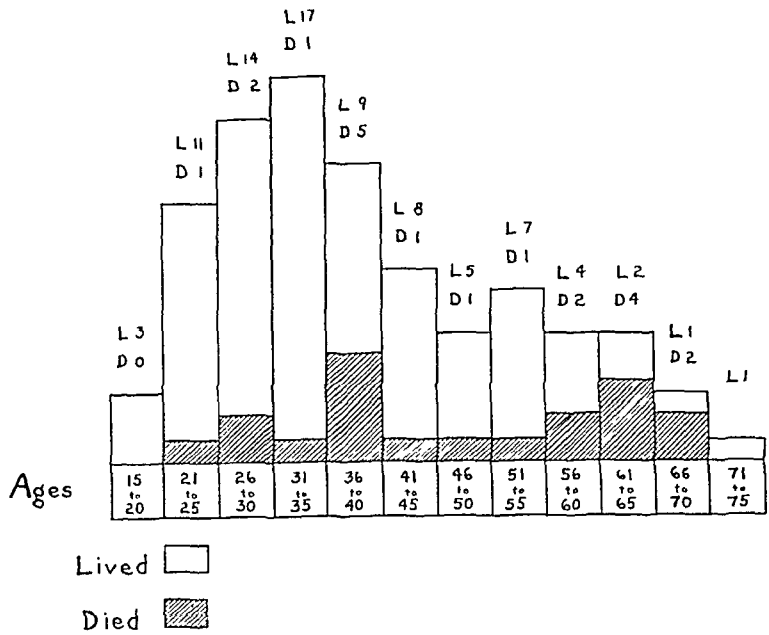


CHART 1.—The relationship between age and mortality.

Roentgenograms, in the erect position, showed subphrenic gas in 73 of the 97 patients so examined. Seventy-eight per cent had flat abdomens, with generalized rigidity. Eight patients had distention on admission, and all died of peritonitis. The remainder had spasticity in the upper epigastrium and often in the right lower quadrant. This latter finding led to seven preliminary diagnoses of acute appendicitis.

Nine patients in this series were not operated upon for closure of a perforation. Three of these with perforations of seven, seven, and six days' duration, were moribund on admission and died within a few hours. One, admitted 31 hours postperforation, had sealed off his ulcer and recovered under conservative treatment. Two, with perforation of 10 and 12 days' duration, were admitted with subphrenic abscess, empyema and pneumonia. They succumbed. Three refused operation. Two of these remained in the hospital five to seven days, sealed-off their ulcers spontaneously, and recovered. One left the hospital the day of admission and has not been traced. This is not, however, an argument for conservative treatment One patient in the

operated group, whose ulcer apparently had sealed-off, on admission, was treated conservatively for several days. It perforated again, and he died following closure.

One hundred and two patients went to the operating room. The relationship of age to mortality in this group is shown in Chart 1, and of hours between perforation and operation, in Chart 2. These relationships are not unusual.

Anesthesia.—Eighty-eight patients were operated upon under spinal anesthesia. This has been discontinued in the later cases, because of two deaths on the table, and one shortly postoperative, due to vascular collapse. These patients were 58, 61 and 69 years of age, and had been perforated three days, three days, and seven hours, respectively. Eight patients were given general anesthesia, and the last six have been operated upon under novocain subcostal block, or intercostal block, as suggested by Bartlett[7].

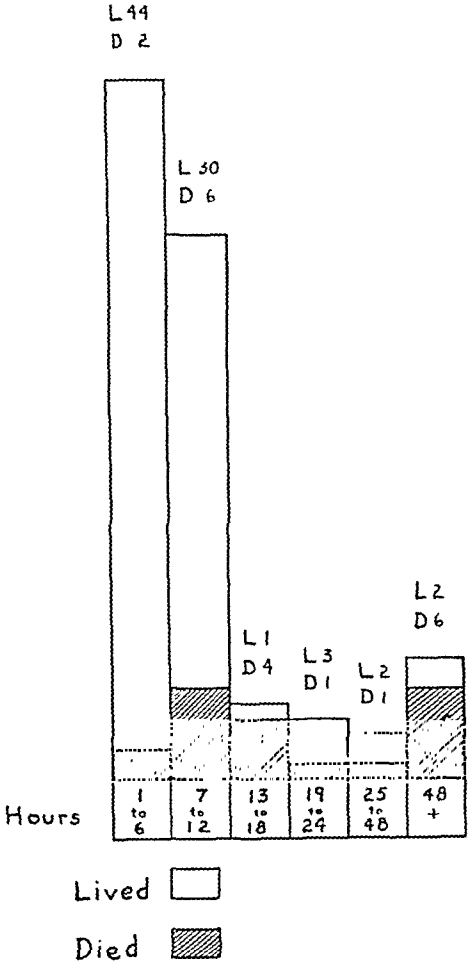


CHART 2.—The relationship between hours from perforation to operation and mortality.

Location of Ulcer.—The site of perforation was recorded as being duodenal, 56 times; gastric, 45 times; and jejunal, once. This distinction, however, is not exact. Anatomic landmarks, such as the pyloric vein, are often obscured, so that the differentiation between duodenal and gastric lesions is inaccurate and may be impossible.

Incisions.—During the past few years, principally in an attempt to decrease wound and pulmonary complications, we have changed from the right rectus to the transverse incision, first, the Singleton,[4] or Sanders,[5] muscle-retracting type; then the muscle-cutting incision, advocated by Lynn[6] and, finally, one-half the Lynn incision (Fig. 1). This is a short, high transverse or oblique skin incision over the right rectus, which cuts all layers transversely. This small incision gives adequate exposure for suture of an ulcer and may easily be extended to care for any lesion in the upper abdomen if necessary. It allows painless respiration, encourages adequate pulmonary ventilation and heals well.

Operations.—The different types of operation carried out, and their mortality rates, are shown in Table I. With three exceptions, these were all carried out by the resident staff of the Louisville City Hospital, under only moderately close supervision.

It is evident that simple closure carries a lower mortality than excision of the ulcer with transverse suture (pyloroplasty). Follow-up shows that this more radical procedure is no more likely to prevent recurrence of the ulcer than is simple suture. Of the 20 patients who survived excision and

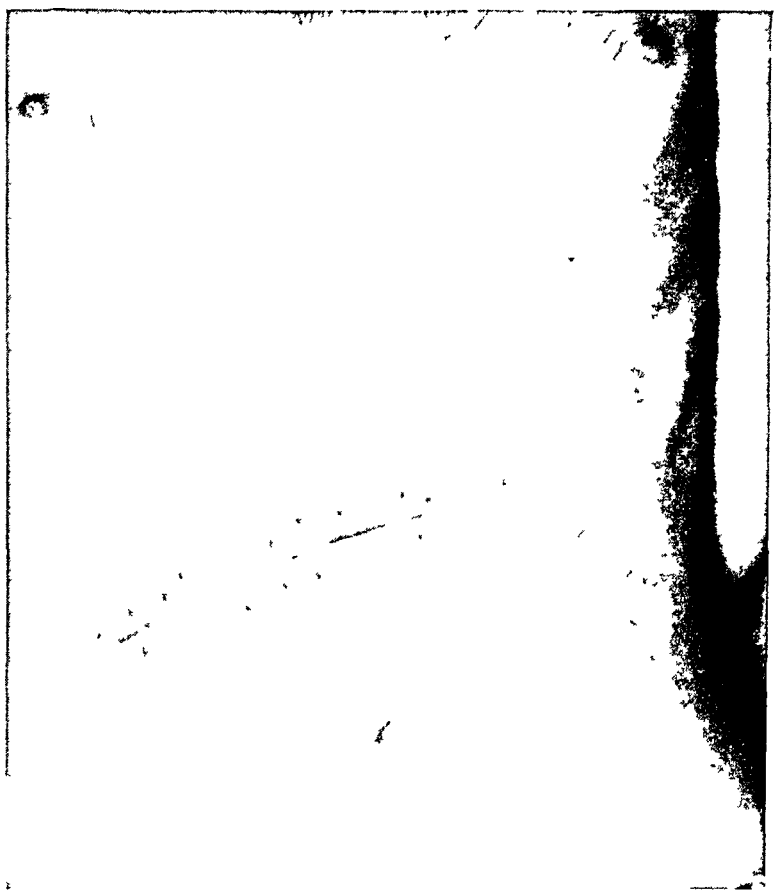


FIG. 1.—Photograph showing the short transverse incision. This particular illustration shows an incision which is a little more oblique than the one usually employed. It divides all structures transversely.

pyloroplasty, there have been five (25 per cent) known recurrences, with two subsequent resections. In the group of 60 simple closures, there have been 11 (18.3 per cent) known recurrences. The one closure, with gastro-

TABLE I

OPERATIVE PROCEDURES EMPLOYED

Operative Procedure	Lived	Died	Total
Simple closure			
Lembert or Cushing 40 / Purse string 20	60	12	72
Excision and pyloroplasty	20	6	26
Purse-string and enterostomy	—	1	1
Purse string and gastro enterostomy	1	—	1
Subtotal gastric resection	1	—	1
Spinal death before closure	—	1	1
Totals	82	20	102

enterostomy, was followed by gastrojejunal ulcer. The patient who underwent resection was free of symptoms after one year. This patient was in the hospital for resection, and perforation occurred on the ward early the morning of operation.

It is felt that simple closure, with Lembert or Cushing sutures, when necessary following the procedure described by Gatch,[1] is the preferred operation. Purse-string closure is more apt to encroach upon the lumen of the pylorus. One of the patients in this series, whose perforation was closed by chromic catgut purse-string sutures, had a stormy convalescence on account of pyloric obstruction. He was readmitted to the hospital a year later on the Medical Service, and died of obstruction, without surgery.

Drainage.—Intraperitoneal drainage was employed in only seven cases, twice in the upper abdomen, three times in the pelvis, and once in both. Such drainage was used, principally, in late cases (six, eight, 16, 20, 48, 84 and 120 hours), and with decreasing frequency in recent years. Four of the seven drained cases ended fatally. Drainage of extraperitoneal tissues alone was employed in 14 cases. This has been discontinued, since the use of sulfanilamide, as will be described later.

Bacteriology.—Culture reports from the peritoneal fluid were available in 65 instances. No growth was reported 34 times. The streptococcus or streptococcal mixtures were reported 18 times; staphylococcus, seven times; colon bacilli and diphtheroids, twice each, bacillus aerogenes and pneumococcus, once each. There was some correlation between the hours postperforation and positive cultures, but this was not as marked as might be expected. Negative cultures were reported in cases from one to 72 hours postperforation, with a median of five hours; while the infected cases ranged from one to 84 hours postperforation, with a median of eight hours. The influence of positive culture, particularly streptococcus, on mortality, was much more marked than can be explained by the slight increase in time. Of the 31 cases with positive culture, there were nine fatalities. Eight of these were associated with streptococcus. Of the 34 patients with negative cultures, only three died. These three were operated upon 14, 19 and 72 hours after perforation. Two of the three died of pulmonary complications and the third was one of the spinal anesthesia fatalities.

The relation of bacteriology to mortality is shown in Table II.

TABLE II

RELATION OF BACTERIOLOGY TO MORTALITY

Type of Infection	Lived	Died
Streptococcus	10	8
Staphylococcus	6	1
B. Coli	2	0
Diphtheroids	2	0
B. Aerogenes	1	0
Pneumococcus	1	0
No growth	31	3
No culture	29	8
Totals	82	20

Causes of Death.—The chief causes of death were as follows:

TABLE III

CAUSES OF DEATH

Peritonitis	10
Pneumonia	4
Atelectasis and pneumonia	2
Circulatory collapse (spinal)	3
Streptococcus septicemia	1
Total	20

Complications.—Two of the patients who died, lived a sufficient length of time to observe the progress of wound healing. In these 84 patients, wound results were as follows:

TABLE IV

WOUND RESULTS IN 84 CASES

Primary healing	55
Wound infection (one hernia)	28
Wound disruption	1
Total	84

Nonfatal complications, aside from peritonitis and wound infection, were: Pneumonia, two; delirium tremens, two; massive atelectasis, one; parotitis, one; postoperative pyloric obstruction, one.

The Use of Sulfanilamide.—As soon as this survey was well under way, the close relationship between the streptococcus and mortality was evident. Accordingly, the local use of sulfanilamide in this, as well as in other contaminated abdominal conditions, seemed advisable. This drug has been advocated by Jensen,[2] and others,[3] in contaminated wounds of the extremities. For the last several months, we have used it in the abdomen whenever contamination was present, including such conditions as perforated peptic ulcer, perforated appendicitis, gunshot wounds of the abdomen, or on other occasions when the lumen of the gastro-intestinal tract was opened. The amounts used have been 5 to 10 Gm. of sulfanilamide crystals in and around the lesion in the peritoneal cavity, and 2 to 5 Gm. in the abdominal wall. The results in the last 12 cases of perforated ulcer and in other abdominal lesions have been encouraging. In the 12 perforated ulcers, in which sulfanilamide was used locally, there was one death. This patient had been perforated three days, and collapsed following spinal anesthesia. There were two mild wound infections. Sulfanilamide by other routes was not administered in these cases, as we wished to study the absorption of the drug from the peritoneal cavity. This absorption is quite rapid. Estimations of blood concentration usually show a peak of 6 mg. or more per 100 cc. of blood, in about four hours, with gradual disappearance from the blood stream within 24 to 48 hours. One patient, not included in this series, who had 10 Gm. implanted in the pelvis and five Gm. in the abdominal wall, reached a concentration of 22.4 five hours after implantation. Peak concentrations of 10 mg. or more are not unusual. A typical blood curve is shown in Table V.

TABLE V

TYPICAL CURVE OF SULFANILAMIDE BLOOD CONCENTRATIONS

Patient C. Q., No. 15439—7/8/40

1:20 A.M.	5 Gm. implanted	
5:30 A.M.	Free, 6.20	Total, 7.42
9:00 A.M.	" 5.29	" 6.44
12:00 Noon	" 4.44	" 6.20
3:00 P.M.	" 3.45	" 6.20
6:00 P.M.	" 2.30	" 5.29
9:00 P.M.	" 2.00	" 3.26

The high blood concentrations obtained would suggest systemic as well as local effect from the drug, although it seems likely that the saturated solution in the peritoneal cavity in direct contact with the bacteria is most effective. Maintaining the high blood concentration by other routes is, of course, advisable.

Present Procedure.—Our present treatment has been evolved gradually from our own experience and a study of the literature. It is as follows:

(1) A short transverse incision under novocain block anesthesia, supplemented when necessary by a small amount of cyclopropane.

(2) Thorough removal of intraperitoneal fluid, including that in the pelvis, by suction rather than sponges.

(3) Simple closure of the ulcer with two layers of interrupted silk sutures from the proximal to the distal side of the ulcer, so as not to encroach upon the lumen of the pylorus. This suture line is reenforced by catching omentum in the outer layer of sutures. The procedure advocated by Gatch[1] is utilized when necessary.

(4) Five to 10 Gm. of sulfanilamide crystals are sprinkled about the lesion and 3 to 5 Gm. are implanted in the abdominal wall.

(5) No intraperitoneal drains are used.

(6) The abdominal wall is closed in layers with silk, without drainage, and a nonconstricting dressing applied.

(7) A Levine tube is passed into the stomach just before or after operation—to remain 24 to 48 hours. If ileus from peritonitis supervenes, the use of the tube is continued.

(8) If the peritoneal culture shows streptococcus, sulfanilamide is pushed by any available route.

(9) Pulmonary complications are combated by such measures as frequent turning of the patient, carbon dioxide inhalations, and bronchoscopic aspiration, if atelectasis occurs.

(10) Salt and fluid balance are carefully controlled.

(11) Transfusions of blood or plasma are administered freely when indicated.

SUMMARY

(1) Analysis of 111 cases of perforated peptic ulcer shows that, aside from the age of the patient and delay in operation, the most important factor

in mortality is the presence of the streptococcus in the peritoneal cavity. Next in importance are pulmonary complications.

(2) The use of sulfanilamide locally and systemically is advocated.

(3) Our present method of treatment is described.

REFERENCES

[1] Gatch, W. D., and Owen, J. E.: ANNALS OF SURGERY, 105, 750, May, 1937.
[2] Jensen, N. K., Johnsrud, L. W., and Nelson, M. C.: Surgery, 6, 1, July, 1939.
[3] Key, J. A., and Burford, T. H.: South. Med. Jour., 33, 449, May, 1940.
[4] Singleton, A. O.: South Med. Jour., 24, 200, 1931.
[5] Sanders, R. L.: ANNALS OF SURGERY, 104, 74, July, 1936.
[6] Lynn, F. S., and Hull, H. C.: ANNALS OF SURGERY, 104, 233, August, 1936.
[7] Bartlett, Robt. W.: Surg., Gynec., and Obstet., 71, 194, August, 1940.

DISCUSSION.—DR. AMBROSE STORCK (New Orleans, La.): A study of perforating peptic ulcers has just been completed at Tulane by Doctors Ochsner and DeBakey. Some of the findings, based on approximately 23,000 cases which have been previously reported by various authors, as well as on case records at the Charity Hospital in New Orleans, were graphically shown in lantern slides. The incidence of perforation in peptic ulcer in the cases collected from the literature was 13.2 per cent, whereas in the Charity Hospital cases it was 8.09 per cent. Charity Hospital records reveal an increase, in recent years, in the percentage of perforation of peptic ulcers. Whereas perforating duodenal ulcer occurs most frequently in the age-group between 20 and 40 years, the peak incidence of perforation of gastric ulcer is in individuals about 50 years of age. In 11,305 cases in which the location of the perforation was accurately recorded, 51.2 per cent were duodenal, 38.9 per cent were gastric, and 9.8 per cent were "pyloric."

There was a constant, direct relationship between the death rate and the age of the patients, and the mortality increased progressively in relation to the number of hours elapsing between the time of perforation and the time of operation. Although the mortality was highest in the group of cases in which local anesthesia was employed, it must be kept in mind that this type of anesthesia was probably frequently employed in cases of long duration or in poor risk patients. The relatively low mortality in the cases in which spinal anesthesia was administered suggests that this type of anesthesia is preferable to general anesthesia. The mortality incidence following various operations was as follows: Simple closure, 25.9 per cent; closure plus gastroenterostomy, 20.4 per cent; excision plus closure or pyloroplasty, 15.9 per cent; and gastrectomy, 13.5 per cent. The relatively high mortality following simple closure was no doubt due to the employment of this procedure in the majority of patients who were in poor condition. On the other hand, the very low mortality following gastrectomy reflects the skill and experience of the relatively few surgeons who employed this method. Excision of the ulcer plus closure of pyloroplasty, while not an operation of great magnitude, is effective not only as a means of meeting the problem of perforation, but the follow-up results following this type of procedure are very satisfactory. The relatively poor follow-up results following simple closure might be reduced if more of the patients in which this procedure is employed were properly instructed in regard to proper postoperative regimen. In 942 cases in which the cause of death was definitely stated, peritonitis was found in 57.1 per cent; pulmonary lesions were present in 20.7 per cent; and other causes were reported in 22.1 per cent.

DR. R. L. RHODES (Augusta, Ga.): There is not much to add to Doctor Griswold's paper, but I wish to report a most unusual case with several particularly interesting features:

Case Report.—A young man, age 17, who had been milk-fed all his life; the exclusion of practically all vegetables; multiple perforations; exception to the old dictum that a peritoneum once insulted is difficult to insult again; and the extraordinarily prolonged effects of eucupin as a local anesthetic.

The first perforation occurred at 1:30 A.M., May 28, 1936. I saw him at 4:30 A.M., and sent him at once to the hospital, where a roentgenogram did not show a gas or air bubble beneath the diaphragm. He was operated upon at 7:30 A.M., and a perforation on the anterior border of the duodenum, one inch from the pylorus, was easily closed with mattress sutures of catgut. Convalescence was uneventful, and he left the hospital on the eighteenth day.

On October 30, 1936, at noon, while on his way home to lunch he was seized with an acute, prostrating pain in his epigastrium, which eased off after reaching home and lying down. At 3 P.M. it recurred and continued until his physician arrived and gave him morphine for relief. I saw him a little later, at which time he told us of a similar attack two weeks previously which, however, remained eased after he lay down for an hour or two. He was sent to the hospital where a roentgenogram, again, failed to show gas or an air bubble beneath the diaphragm.

Operation, at 7 P.M., revealed a diffuse peritonitis and an actively leaking perforation in the duodenum, two inches from the pylorus, one inch beyond the scar of the former perforation. About one inch further, the duodenum was adherent to the under surface of the liver and snugly covered with omentum. The perforation was closed as in the former instance. The adherent omentum was then freed from the liver and the duodenum carefully separated, when we opened into an abscess of about two drams of pus, and revealed a perforation one-quarter inch in diameter in the duodenum, which was closed. This perforation probably accounted for the acute pain two weeks previously, but sealed itself against the under surface of the liver. Two cigarette drains were introduced, and brought out through a stab wound in the flank. The incision was closed in layers with chromic catgut and several through-and-through silver wire tension sutures were inserted.

His convalescence was most stormy—through the gamut of a diffuse peritonitis; the wound laid wide open; the silver wires cutting out; and resulting evisceration. This was controlled by a rubber sheet dam with rolls of gauze packed in the gutter and snugly strapped with adhesive. After three weeks he began to improve and was allowed to go home four weeks later, where he remained in bed until the wound was completely healed, four months after operation. Most of the right rectus muscle and fascia had sloughed away and he had a large hernia, three inches wide and the full length of the incision. For this he was given an elastic girdle which he wore for about a year, not only to help hold the hernia but to prevent or lessen further retraction of muscles of the right side of the abdominal wall.

On March 26, 1938, the third operation, closure of the hernia, was performed under local anesthesia field block and infiltration, using eucupin procaine solution. This operation, as you know, was necessarily quite tedious and slow, required about five hours and is why local anesthesia was selected, as well as to avoid all involuntary muscular effort such as coughing, etc. The edges were freed and approximated where possible and flaps of left rectus fascia where necessary, and dozens of silk sutures were used, until closure was satisfactory. Examined last week, he was found to be in excellent physical condition, without any evidence of hernia. I was particularly impressed by the prolonged effect of the eucupin and commend it to your consideration.

DR. A. O. SINGLETON (Galveston, Tex.): There are many phases of this question which one may discuss. I would like to call attention to perforating

gastric and duodenal ulcers in the newborn. They are quite common, and apparently not very frequently diagnosed and operated upon. About two years ago we operated upon an infant three days old, with a perforated gastric ulcer. About three months ago we operated upon one 14 hours old. Both babies died of peritonitis. The literature reports many having been found at autopsy. Lee reported one stomach ulcer perforated *in utero*. Many ulcers have been found at autopsy which have not been perforated.

The cause of these perforations is very interesting to speculate upon: The first symptom noted is distention. More positive diagnosis can be made if roentgenograms reveal free gas in the peritoneal cavity. We were hopeful we would find one upon whom operation could be performed without delay, as we felt the delay was the cause of death of the first one. So we operated upon the second case early, but it also died from peritonitis. Whether chemotherapy would have helped we do not know, but if we have another we will use sulfonamide, as suggested by Doctor Griswold.

Dr. J. M. T. Finney, Jr. (Baltimore, Md.): We hear, from time to time, about familial tendencies in various conditions, and I would like to put on record three cases, brothers, upon whom I have operated for perforated ulcer, at one time or another. Two of these had perforations without any obtainable previous history of ulcer; the third had had stomach trouble for many years. In all three, the perforations occurred between the ages of 70 and 72, and in no instance was malignancy found. I am glad to say they all survived. That is the only instance of perforated ulcer in three members of the same family that I know of.

I would like to call attention to an article published some years ago in Surgery, Gynecology and Obstetrics by a member of this Association, Doctor Robert T. Miller, Jr., in which he advocated cutting the round ligament of the liver under the umbilicus, but leaving it attached to the edge of the liver, and using the cut end as a plug in the hole, where induration makes a stitch almost impossible, and the surrounding tissue is difficult to use. The round ligament has fibrous tissue in its structure and makes an excellent plug where one has difficulty closing the perforation by simple suturing. I have employed this technic on numerous occasions, with great satisfaction.

Dr. Joseph M. Donald (Birmingham, Ala.): Treatment of perforated duodenal ulcer by excision of the ulcer followed by a Judd pyloroplasty has been employed in approximately 40 per cent of such cases admitted to the Hillman Hospital during the last seven years. This procedure is reserved for those patients in whom the perforation is of less than eight hours' duration, and in which the duodenum is easily accessible. Our mortality rate following this type of treatment has been less than that following simple closure. This, of course, is due to the better-risk patient. However, we have found it possible to obtain a much better closure of the duodenum following excision of the ulcer than is the case following simple closure, when the sutures so frequently cut through the friable tissue around the perforation. The fact that many of the surgeons on the staff of the Hillman Hospital prefer excision and pyloroplasty to simple closure in selected cases, speaks well for the procedure.

Regardless of the type of operation, recurrence will occur in a small percentage of cases. In one patient, in whom the ulcer was excised and pyloroplasty performed, a second perforation occurred in the same portion of the duodenum, three years later.

I was particularly interested in Doctor Griswold's remarks relative to

the absence of shock in instances of perforated duodenal ulcer. I have seen only one case in which shock was present in the early stage of perforation. This patient was seen with Dr. H. E. Simon. He was an elderly male, and was in extreme shock from the very onset of pain. His condition did not permit exploration and death occurred within 24 hours. Autopsy revealed two large, perforated duodenal ulcers, which had apparently perforated simultaneously. Ordinarily shock is present only in the late cases associated with generalized peritonitis.

Finally, I would like to reemphasize the importance of the transverse abdominal incision in cases of perforated duodenal ulcer, as recommended by Doctor Griswold. In a recent study of wound disruptions, I was surprised to find that of 32 such cases, six (approximately 20 per cent) followed right rectus incisions for perforated duodenal ulcer.

DR. R. ARNOLD GRISWOLD (Louisville, Ky., closing): I have very little to add except a note about the difficulties of simple suture in cases with a large area of indurated, friable tissue surrounding the ulcer. Sutures tear out of this tissue very easily. In these cases we have employed the technic which Gatch reported before this Association in 1936, in which the anterior wall of the stomach is sutured to the anterior wall of the duodenum, thus closing over the ulcer without introducing sutures through the friable tissue. Since we have been employing this simple method we have not seen a case which could not be closed without resorting to excision and pyloroplasty or other more radical procedures.

RESECTION OF THE DUODENUM FOR TUMOR OF THE AMPULLA OF VATER*

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CANCER of the head of the pancreas or cancer of the ampulla of Vater or duodenum, invading the head of the pancreas, was considered a necessarily fatal condition until about 22 years ago, when Coffey[1] first devised an operation for resection of the head of the pancreas and the duodenum. It was,

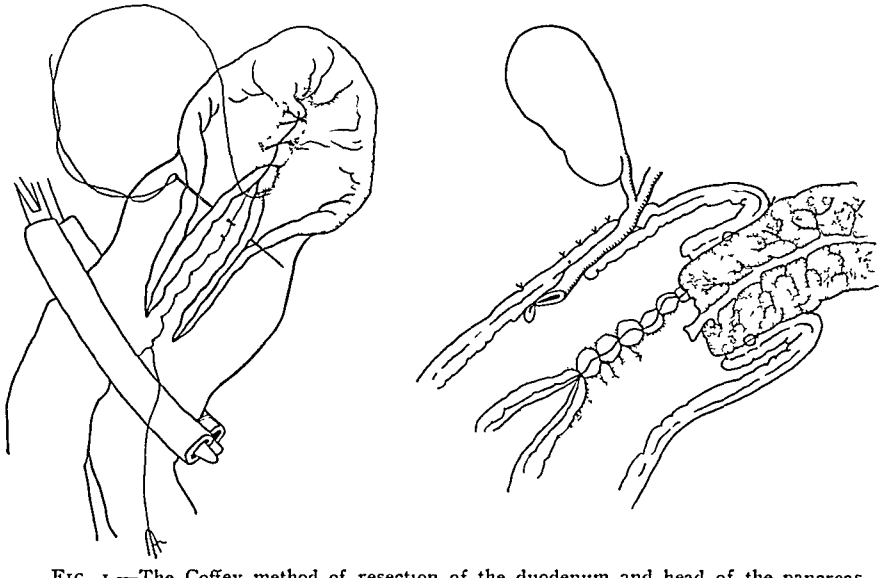


FIG 1.—The Coffey method of resection of the duodenum and head of the pancreas A receptacle is made for the stump of the pancreas out of a loop of jejunum The common duct is obliquely inserted lower down.

for a time, thought that resection of the duodenum must be fatal because of the loss of some vital secretions. Coffey disproved this in his experiments on dogs. I do not know of any patient that Coffey operated upon, though his experimental work on the lower animals and that upon the cadaver was extensive. He provided in the jejunum a receptacle for the stump of the pancreas after the duodenum and the head of the pancreas had been excised. He transplanted the common bile duct obliquely into the jejunum lower down (Fig. 1).

In 1922, Frank C. Mann and Kyoichi Kawamura[2] published a paper on an experimental study of duodenectomy. They developed a technic for excision of the duodenum and transplantation of the common duct and the pancreatic duct. Most of the work was done upon dogs, in one stage. They

* Read before the Fifty-third Annual Session of the Southern Surgical Association, Hot Springs, Va., December 12, 1940.

reported that no noticeable change followed duodenectomy except that in two of ten dogs a typical peptic ulcer developed on the jejunal side of the gastrojejunal anastomosis. Apparently, excision of Brunner's glands had no perceptible effect.

Dragstedt, Clark and Vermeulen[3] have developed an extract from the pancreas which they named "lipocaic." This extract when fed to dogs which have developed fatty liver after excision of the pancreas restores the histology and the function of the liver to practically normal. Apparently feeding fresh pancreas does the same. They seem to have demonstrated that it is this

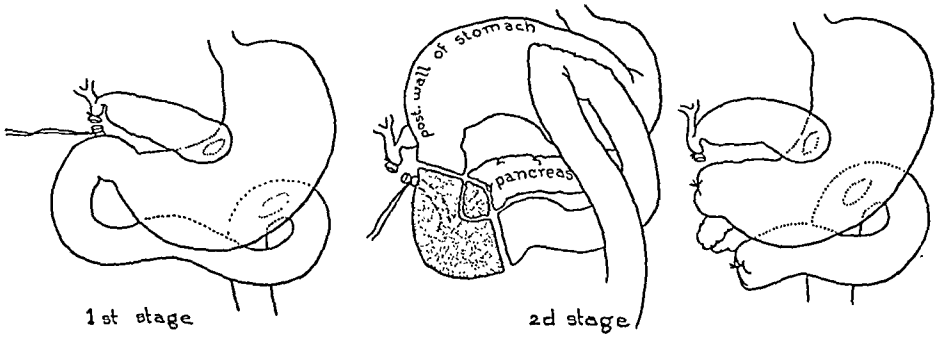


FIG. 2.—Original technic of operation by Whipple, Parsons and Mullins. In the first stage the gallbladder is united to the stomach; the common duct is doubly ligated and divided; and a posterior gastro-enterostomy performed. In the second stage the duodenum and the head of the pancreas are excised; and the pancreatic duct is ligated. Then both stumps of the duodenum are closed; and the stump of the pancreas is sutured.

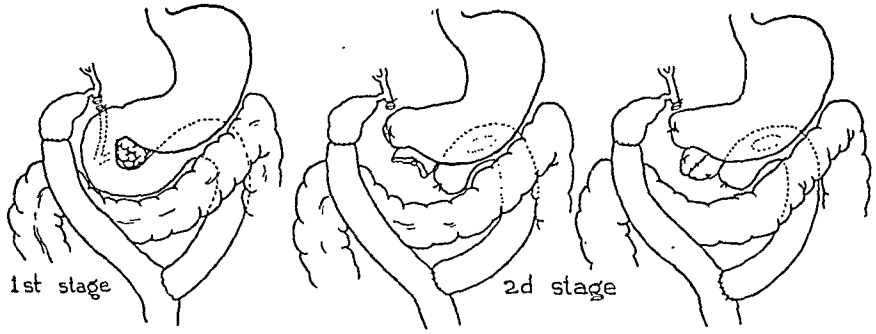


FIG. 3.—Whipple's modification of the operation shown in Figure 2, in which the gallbladder is united to the jejunum instead of to the stomach.

extract and not cholin or lecithin that is responsible for this reaction. They believe that the absence of pancreatic juice from the intestine is relatively unimportant, and leads only to partial impairment of digestion or absorption, whereas the absence of the internal secretion lipocaic or insulin is incompatible with life. The ligation of the pancreatic duct does not appear to affect the internal secretions of the pancreas, lipocaic and insulin.

The physiologists have shown that the external secretion of the pancreas is not essential to life, and based upon this fact the surgical technic for excision of the duodenum and the head of the pancreas is appreciably simpler.

Whipple, Parsons and Mullins[4] were pioneers in advocating operation founded on this principle. Their original operation was undertaken in two

stages: The gallbladder was first anastomosed to the stomach, a gastro-enterostomy was performed, and then, at a later stage, the duodenum and the head of the pancreas were excised and the pancreatic duct was ligated (Fig.

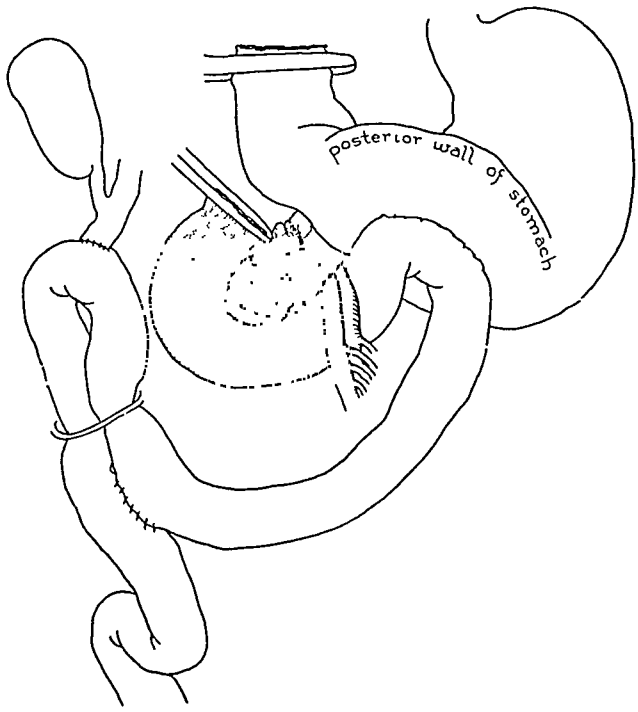


FIG. 4.—The final modification that Whipple has made is to unite the common duct, instead of the gallbladder, to the jejunum.

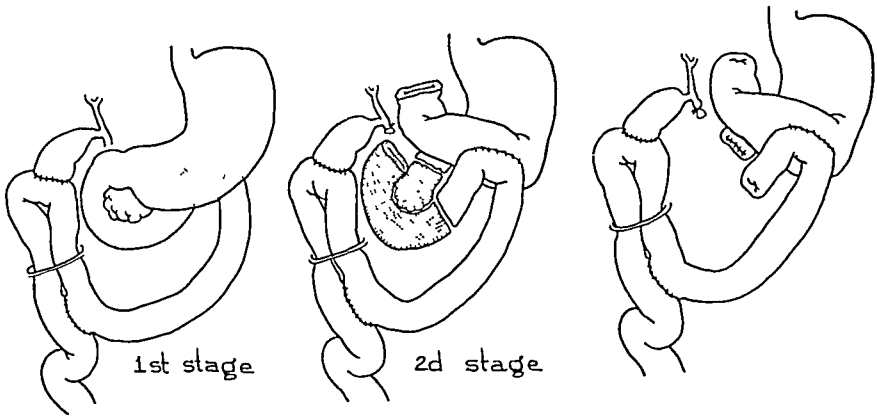


FIG. 5.—Brunschwig's operation is much like the second modification of Whipple, except that the jejunum is brought through the mesentery of the transverse colon.

2). Whipple modified this by uniting the gallbladder to the jejunum instead of to the stomach. He divided the jejunum about 10 to 12 cm. below its origin; transplanted the proximal end into the side of the jejunum farther down; and then united the gallbladder to the lower stump (Fig. 3). He later

found that there might be a troublesome leak in the ligated stump of the common duct, so he abandoned this procedure, and he now unites the end of the common duct to the jejunum[5, 6] (Fig. 4). Whipple believes that patients in whom the pancreatic duct is ligated do not suffer materially from suppression of the pancreatic juice or from fatty degeneration of the liver.

Brunschwig[7] has advocated a technic for excision of the duodenum and head of the pancreas in which a loop of jejunum is brought up through the transverse mesocolon and united to the gallbladder (Fig. 5).

Baggenstoss[8] reports that papillomata of the ampulla of Vater are apparently more frequent than is generally recognized. They often create no symptoms, but because of the peculiarities of the structure of the large papillomata of the ampulla of Vater they probably are in close relationship with carcinoma.

Case Report.—No. B-8421: D. C., white, male, age 60, had a history of intense jaundice for about seven weeks. He had, apparently, been in good health until February 20, 1940, when he noticed that his urine was highly colored. On March 11, 1940, he went to his physician, who gave him medical treatment. He gradually became more deeply jaundiced. His urine was highly colored and concentrated, and he had a generalized pruritus. The stools were clay-colored. He had two attacks of severe, nonradiating pain in the upper abdomen. They were relieved by hypodermics. The patient stated that he had had a similar attack about 15 years ago, which cleared up under medical treatment.

Physical Examination.—The patient was deeply jaundiced, with an icterus index of 180. There were numerous areas of superficial abrasions from scratching. The abdomen was distended. The patient was rather stout. It seemed probable that there was a stone in the common duct, though cancer of the head of the pancreas could not be excluded. The liver was palpable on deep inspiration. There was moderate pain over the region of the gallbladder. The pulse rate was 72, and the blood pressure was 110/40. He was kept in the hospital three days, and given preliminary treatment, including vitamin K and bile salts.

Operation.—April 16, 1940: The gallbladder was dilated and adherent. The adhesions were separated. The gallbladder was opened and found to contain a quantity of thick fluid that appeared to be chiefly mucus. It was explored with the finger. There were no stones, and no stones could be palpated in the common duct. The duodenum was contracted and contained a small mass about the region of the ampulla of Vater. The head of the pancreas was slightly infiltrated, but, on the whole, the growth seemed to be easily resectable. It was decided to remove a segment of duodenum with the attached portion of the pancreas. The duodenum was mobilized, and occluded with a rubber band well below the growth. It was divided a short distance below the growth and a protuberance was seen apparently originating from the ampulla of Vater. It was fairly well fixed, and there was infiltration into the pancreas beneath this. The duodenum was also divided with the cautery a short distance below the pyloric sphincter, and this isolated segment of the duodenum including the tumor, and with a portion of the attached pancreas, was removed with the cautery. The tissues were quite vascular, but the bleeding was easily controlled. The end of the common duct was greatly dilated, permitting the entrance of the finger. It poured out "white bile," without a tinge of color. The pancreatic duct came out of the stump of the pancreas a short distance from the common bile duct and was not dilated.

It seemed possible to make an end-to-end union of the lower stump of the duodenum, which was rather small, with the greatly dilated common duct. The posterior margin of the lower stump of the duodenum was sutured to the posterior margin of the dilated

common duct with interrupted sutures of fine silk (Fig. 6), which were also placed anteriorly. These sutures puckered the duodenum considerably. Anteriorly, and on the side, additional sutures of silk were inserted. Over these sutures interrupted sutures of fine chromic catgut brought over the duodenum so the entire stump of the pancreas was covered. The ends were left long. In this way there was a union of the puckered lower end of the duodenum to the large common duct and the pancreas. No effort was made to secure the pancreatic duct separately. It was apparently not enlarged. By the outer row of sutures, the duodenum was attached to the margin of the stump of the pancreas so that the duct of the pancreas would probably drain into the loose

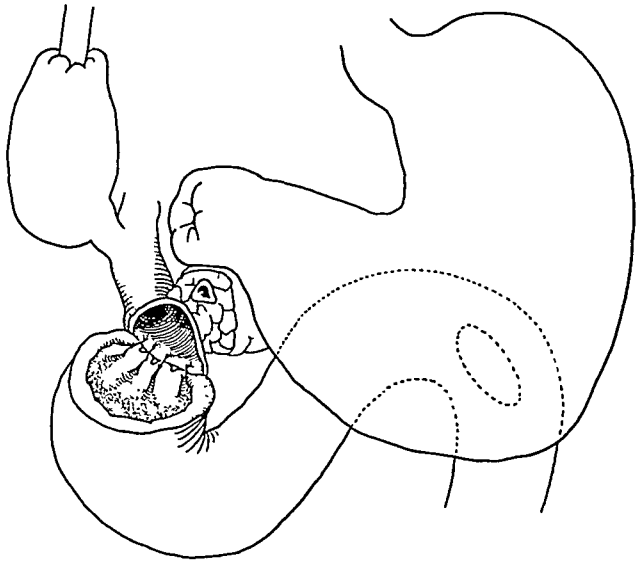


FIG. 6.—In the operation performed in the reported case, the distal stump of the duodenum was sutured to the greatly enlarged common duct. The undilated pancreatic duct is shown in the stump of the pancreas near the common bile duct.

anastomosis of the common duct and the duodenum. Thus, there were anteriorly three layers of sutures—two of interrupted sutures of silk, and the outer row of interrupted sutures of fine chromic catgut. All of the raw surface of the stump of the pancreas was covered. (Fig. 7.) The ends of the outer row of sutures, which were of fine chromic catgut, were threaded in a needle and passed through a tag of omentum so that the union was well reenforced.

The upper end of the duodenum was folded in and sutured, and a posterior gastroenterostomy was performed. As the gallbladder had already been opened, a drainage tube was placed in it. A stab wound was made in the right flank, and a rubber tube and a cigarette drain were placed down to the region of the foramen of Winslow.

Postoperative Course.—The patient stood the operation remarkably well, and left the table with a pulse of 88. For the first 36 hours his convalescence appeared to be entirely satisfactory. On the afternoon of the day after the operation his temperature was 99° F., pulse 94. The secretion of urine, however, was failing. On the fourth day he passed only 15 cc. of urine. He died on the fifth day after operation, his temperature reaching 103.5° F., pulse 160, just before death.

Necropsy.—The healing around the site of the anastomosis was in good condition. There was intense jaundice. About 300 or 400 cc. of bile-tinged fluid was found in the peritoneal cavity. There was no evidence of peritonitis or leakage of the sutures at any point. There were some partly organized blood clots in the head of the pancreas, and slight evidence of necrosis where the cautery had been used, but there was no infection in this region. The kidneys were slightly enlarged and deeply stained with bile, and their surfaces indicated nephritis. The liver was enlarged. The lower lobe

of the right lung was compressed, and the lower lobe of the left lung was almost solid, from what seemed to be hypostatic pneumonia The patient apparently died of uremia.

Pathologic Examination.—Gross: The specimen consisted of the segment of the duodenum, which measured 4.5 cm. in length. Attached to it is a portion of the pancreas. From the region of the ampulla a protuberance, 1.5 cm. in length and 1 cm.

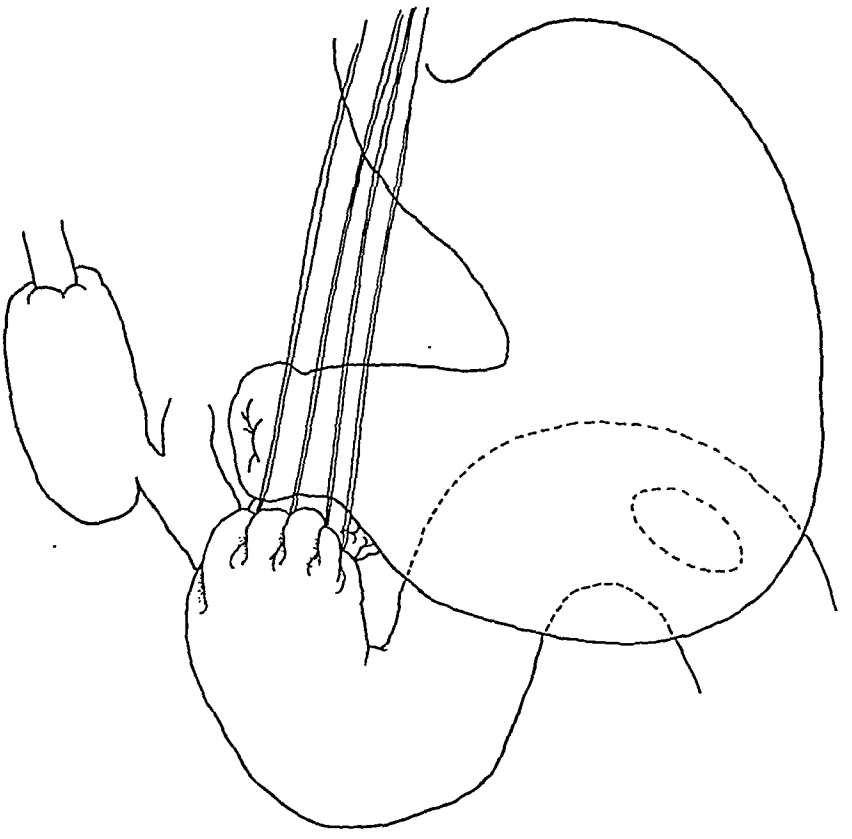


FIG. 7.—The anterior sutures between the duodenum and the end of the common duct have been inserted. Another row of silk sutures is placed around this, and the final row of sutures of fine chromic catgut is being inserted so as to fold over the duodenum and cover the stump of the pancreas. Finally, the ends of this outer row of fine chromic catgut sutures are threaded in a needle and passed through omentum.

in breadth, presents. On the posterior surface is the greatly dilated end of the common duct, about 1.5 cm. in diameter. Near it is the pancreatic duct, which does not seem to be enlarged. The pancreatic tissue adherent to the specimen measures 3.5x3x3 cm. (Figs. 8 and 9).

Microscopic.—The tumor showed an adenomatous structure with some hyperplasia of the epithelial cells in certain areas but apparently no malignancy (Figs. 10 and 11). The adherent pancreatic tissue was rather hard and appeared to be infiltrated. The pancreatic tissue showed a tendency to hyperplasia but no malignancy. The tumor produced complete obstruction in the ampulla, and probably from pressure and the local hyperemia caused inflammatory reaction and hyperplasia in the adjacent portion of the pancreas.

The case is of interest as presenting a somewhat unusual condition. It may be that operation should have been undertaken in two stages, but the facts that the growth, which was thought to be cancer, was not extensive and seemed to be readily resectable; that there were around the gallbladder many adhesions which doubtless would have recurred at the second stage of the

operation; and that the patient seemed to be in excellent general condition, appeared to indicate a one-stage procedure. The presence of "white bile" showed, of course, that the hepatic function was at a very low ebb.

FIG. 8



FIG. 9





FIG. 10.

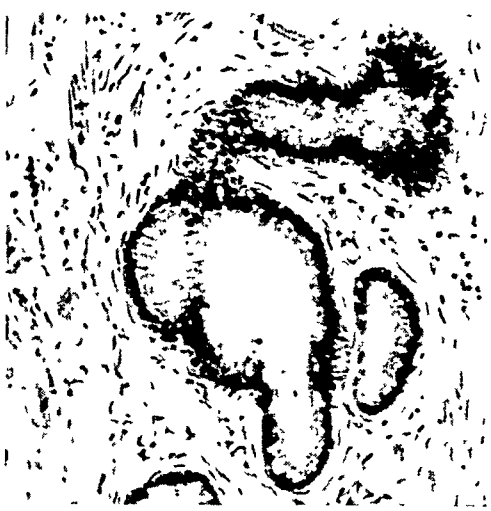


FIG. 11.

FIG. 8.—Drawing of the specimen shows attached pancreas, the greatly dilated bile duct, and, adjacent to it, the pancreatic duct. At the end of the segment of duodenum is a protruding tumor.

FIG. 9.—Drawing showing tumor after the duodenum has been opened. It was firm, and fully occluded the ampulla.

FIG. 10.—Photomicrograph of the tumor shows an adenoma, or fibro-adenoma, in which there is some hyperplasia of the epithelial cells but no malignancy. (×100)

FIG. 11.—The central portion of the preceding figure, with hyperplasia of the cells of one of the acini, though it is not malignant (×250)

The operation, as advised by Whipple, and others, for excision of the head of the pancreas and the duodenum for cancer of the pancreas or cancer of the duodenum that infiltrates the pancreas, is made possible by the physiologic finding that the presence of pancreatic juice in the gastro-intestinal tract is not essential to life, but that the internal secretions of insulin and of lipocaic are essential to life. These internal secretions appear not to be affected by suppression of the external secretion. It would seem, however, that

if the external secretion of the pancreas can be preserved without too complicated a technic, this should be done. The operation in the case reported above does not lend itself to extensive resections in which much of the pancreas must be removed. In such instances the most recent modification of Whipple's operation in which the end of the common duct is united to the jejunum after ligating the pancreatic duct would appear to be the best procedure.

REFERENCES

[1] Coffey, R. C.: Pancreato-Enterostomy and Pancreatectomy. ANNALS OF SURGERY, 50, 1238, 1909.

[2] Mann, Frank C., and Kawamura, Kyoichi: Duodenectomy: An Experimental Study. Collected Papers of the Mayo Clinic, W. B. Sanders Co., 13, 132, May, 1922.

[3] Dragstedt, Lester R., Clark, Dwight E., and Vermeulen, C.: The Significance of Lipocaic in Surgery. ANNALS OF SURGERY, 110, 907, 1939.

[4] Whipple, A. O., Parsons, W. B., and Mullins, C. R.: Treatment of Carcinoma of the Ampulla of Vater. ANNALS OF SURGERY, 102, 763, 1935.

[5] Whipple, A. O.: Surgical Treatment of Carcinoma of the Ampullary Region and Head of the Pancreas. Am. Jour. Surg., 40, 250–253, 1938.

[6] Whipple, A. O.: Personal communication, May 17, 1940.

[7] Brunschwig, Alexander: Resection of the Head of the Pancreas and Duodenum for Carcinoma—Pancreatoduodenectomy, Surg., Gynec., and Obstet., 65, 68, 1937.

[8] Baggenstoss, Archie H.: Major Duodenal Papilla: Variations of Pathologic Interest and Lesions of the Mucosa. Arch. Path., 26, 853, October, 1938.

SECONDARY OPERATIONS ON THE BILIARY SYSTEM*

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WITH THE EXCEPTION of appendicitis, probably no abdominal disease requires the surgeon's attention more frequently than does cholecystitis and the various processes involving the bile ducts, pancreas and liver so frequently associated with it. In Central Pennsylvania in the general hospital with which we are associated, drawing its patients from a large and representative American population, and with all types of surgical and medical conditions being seen, the incidence of cholecystitis admissions is 2.8 per cent, while the disease constitutes 9.1 per cent of all the admissions to the Surgical Service.

One is impressed by the high incidence of cholecystic disease among our American population. It seems especially marked among our rural American housewives. Surely, it is one of the commonest conditions with which we are confronted, yet much light must be thrown upon the question of liver physiology, on the chemistry of cholesterol metabolism, and on the rôle played by infection before its etiology can be fully understood. The sedentary, unhygienic lives of its victims, characterized so commonly by overeating and obesity, no doubt are important contributing factors.

Treatment of patients suffering from diseases of the biliary tract is, therefore, one of the chief tasks of the surgeon, one which, as our knowledge of the physiology of the liver and gallbladder advances, as it has so notably during the past few years, becomes continually more engrossing. While the first cholecystostomy was performed, in 1878, by Sims, and the first cholecystectomy, in 1882, by Langenbeck, it has only been during the past 25 years that the most significant facts regarding cholecystitis have been acquired. The men of this group of my age, or thereabouts, have witnessed and even taken an active part in nearly all the important developments of our knowledge of diseases of the biliary system. It is of historic interest, that some of the most important contributions to this subject have been made at the meetings of this Association.

As William Mayo's assistant, the senior author recalls the storm created by the cholecystectomy-cholecystostomy question, then so vehemently debated, and have listened to many of the other controversies which, from time to time, have enlivened our medical meetings, down to the more recent one dealing with the problem of when to operate once confronted with the patient suffering from acute cholecystitis.

It is the accepted practice to perform, when stones are found, a cholecystectomy, and even to carry out this procedure when no calculi are present,

* Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

providing the gallbladder is clearly diseased. Also, it is considered as an imperative procedure to open and explore, and usually drain, the common duct if it is enlarged, or stones are felt within it, or the clinical history and laboratory information suggest the presence of calculi. Thus, surgical treatment of these lesions has become fairly standardized, and the pooling of conclusions, resulting from large clinical experiences by men of sound judgment, has contributed in reducing mortalities probably to an irreducible minimum and in achieving results as good as, possibly, they ever can be. Yet, one should not be too prophetic, for such a statement a few years hence may sound as shortsighted as does that of Lawson Tait who, 62 years ago, in reference to Marion Sims' original paper remarked, "The entire possibilities of treatment of gallstones and distended gallbladder are exhausted by Sims' paper" (quoted by Brooks and Wyatt[3]).

In this study, we have been particularly interested in the mechanism accounting for a continuation of symptoms once a patient has been operated upon, but who is obliged to return for a second or even third time because of symptoms similar to those for the relief of which the first operation was performed. At the same time we have been particularly desirous of discovering what possible errors of judgment or of surgical technic, especially when the first operation was performed by ourselves, might have accounted for the return of trouble, with the hope that they may in the future be avoided.

The gallbladder patients whose records form the basis of this investigation were all treated on the senior author's service, and were operated upon by him or by his assistant. Among the 2,485 patients in this series, there were 140 upon whom we were obliged to reoperate. Sixty-eight and five-tenths per cent of the patients had their first operation elsewhere, the remainder, 31.5 per cent, had previously been operated upon by us. One hundred and nineteen, or 85 per cent were females, and 21, or 15 per cent, were males. The average age at the time of the primary operation was 40, at the secondary one, 48. While all presented interesting and variable problems, yet it was the patient upon whom we had previously operated whom we studied most critically and whose pathologic states we, naturally, examined at the second operation with especial diligence and solicitude.

STATISTICAL STUDY

Of the 140 patients, a previously drained gallbladder was found in 74.2 per cent. Of these patients, 20.1 per cent had been previously operated upon by us and 79.9 per cent elsewhere. Of the gallbladders removed at the second operation, 58 per cent contained stones, either overlooked at the first operation or having subsequently reformed, while 41 per cent contained none. Seven were suffering from an acute empyema at the time of the second admission. Ninety-five patients had secondary operations following a primary cholecystostomy. At the operation, the gallbladder was removed in all but 11, the common duct being explored in 27 per cent. When the gallbladder was permitted to remain at the secondary operation it was only because it had

become atrophied and apparently innocuous. Of the entire series of 140 patients operated upon secondarily, 47 (34 per cent) required a choledochostomy, the drain, a T-tube, being permitted to remain in place on the average of 16 days.

Jaundice following a primary cholecystostomy was present with 49 patients, or 53 per cent of the cholecystostomy group of 95 patients. Of the 95, 24 had dilated common ducts with stones present, but in ten, although the duct was obviously enlarged, no calculi were found. In eight, although jaundice was present, the common duct appeared normal and contained no stones. Seven had an acute empyema—four with stones in the cystic duct.

Of 33 patients previously having had a cholecystectomy, 42 per cent had been operated upon elsewhere, and 58 per cent by myself.

Of the 33 patients upon whom a cholecystectomy had been performed, stones were found in the common duct in 11, or one-third of the total, while in 22, none were found. A postoperative stricture was found in six.

Fifteen patients were admitted because of chronic postoperative biliary fistulae, the sinuses having been in existence for from one month to seven years, the average duration having been 16 months. Eight of these required a cholecystectomy to correct the difficulty, while three, in addition, required drainage of the common duct. The remainder were cured by excision of the sinus with various plastic operations upon the common duct.

Of the 33 patients who had had a simple cholecystectomy and who still presented symptoms, 66.6 per cent required a choledochostomy, the remainder needing, in addition, various plastic operations upon the common duct, and one, a choledochogastrostomy.

Fourteen patients, or 10 per cent of all those having secondary operations, had marked evidences of chronic pancreatitis, as revealed by enlargement and induration of the pancreas, especially in the region of the common duct. Upon eight of these patients, a cholecystostomy had previously been performed, and on six, a cholecystectomy.

Among the entire group there was one case of carcinoma of the pancreas, one of the bile ducts, and one of the gallbladder.

Stricture of the common duct was discovered in six patients. One of these had been operated upon by us, the other five elsewhere. All had cholecystectomies at the first operation, on the average of 31 months prior to the second celiotomy.

Eleven patients had been operated upon twice before and one, three times, the latter having had the gallbladder opened and drained three times prior to her coming to us, at which time a cholecystectomy was carried out. In practically every instance, when patients had been operated upon two or more times, the final operation consisted of a cholecystectomy for the removal of a previously drained gallbladder. In 51 per cent of this group, the common duct was also explored and drained.

The average hospital postoperative days for the entire series was 21. The hospital mortality for the group was 8.6 per cent. Deducting seven patients

who were found to have inoperable lesions, carcinoma, hopeless destruction of the common duct, *etc.*, and upon whom merely an exploration was carried out, leaves a mortality for all those having secondary operations upon the gallbladder and biliary ducts of 6.4 per cent.

TABLE I

SECONDARY OPERATIONS UPON GALLBLADDER AND BILIARY DUCTS

Number of gallbladder patients	2,485
Number of gallbladder patients having secondary operations	140

TABLE II

PRIMARY OPERATIONS ON GALLBLADDER AND DUCTS

(*140 Patients*)

		Where Performed	
Number of Previous Operations	Patients	G. M. H.	Elsewhere
One	129	38 (29.4%)	91 (70.5%)
Two or more	11	4 (36.3%)	7 (63.6%)
Total	140	42 (30%)	98 (70%)

TABLE III

SEX INCIDENCE AND AGE

Sex

Male	Female
21 (15%)	119 (85%)

Average Age

Primary Operation	Secondary Operation
40	48

TABLE IV

PRIMARY OPERATIONS

	No. of Cases
Cholecystectomy	24
Cholecystectomy and choledochotomy	6
Cholecystectomy and choledochostomy	3
Cholecystostomy	95
Exploration (elsewhere), but gallbladder found normal	1
Multiple operations:	
Cholecystostomy (2)	5
Cholecystostomy (3)	1
Cholecystectomy and chronic biliary fistula	2
Cholecystostomy and cholecystectomy	1
Cholecystectomy and cholecystostomy	1
Cholecystostomy and choledochotomy	1
Total	140

TABLE V

PATIENTS HAVING SECONDARY OPERATIONS FOLLOWING PRIMARY CHOLECYSTOSTOMY

(*95 Patients*)

Average Period of Relief
3.7 years

Average Time Interval Between 1st and 2nd Operation
8.1 years

TABLE VI

TIME INTERVENING BETWEEN PRIMARY CHOLECYSTOSTOMY AND SECONDARY OPERATION

(*95 Patients*)

	Average Duration of Symptoms	Average Time Between Operations
No relief—20%	4 years– 5 months	4 years–5 months
Those having some relief—80%	2 years–11 months	7 years–7 months

TABLE VII

JAUNDICE FOLLOWING PRIMARY CHOLECYSTOSTOMY

(*52 Patients*)

Operative Findings

	No. of Cases
Dilated common duct with stones	28
Dilated common duct without stones	10
Common duct appeared normal	8
Empyema	3
Pancreatitis with obstruction	2
Carcinoma of gallbladder	1
Total	52

TABLE VIII

TYPES OF SECONDARY OPERATIONS FOLLOWING PRIMARY CHOLECYSTOSTOMY

(*95 Patients*)

Cholecystectomy	65 or 68.4%
Cholecystectomy and choledochotomy	4 or 4.2%
Cholecystectomy and choledochostomy	15 or 15.7%
Cholecystostomy	4 or 4.2%
Choledochotomy	2 or 2.1%
Miscellaneous	5 or 5.2%
Exploration and biopsy	1
Excision of sinus	2
Incision and drainage, pancreatic cyst	1
Cholecystectomy and transduodenal choledochotomy	1

TABLE IX

TIME INTERVENING BETWEEN PRIMARY CHOLECYSTECTOMY AND SECONDARY OPERATION

(*33 Patients*)

	Average Duration of Symptoms	Average Time Between Operations
No relief—42%	2 years– 4 months	2 years–4 months
Those having some relief—57%	2 years–10 months	4 years–3 months

TABLE X

FINDINGS AT SECONDARY OPERATIONS FOLLOWING PRIMARY CHOLECYSTECTOMY

(*33 Patients*)

	No. of Cases
Stones in common duct	11
No stones in common duct	22
Common duct normal	6
Common duct stricture	6
Pancreatitis	6
Cirrhosis (marked hepatitis)	3
Carcinoma of pancreas	1
Carcinoma of bile duct	1
Total	33

TABLE XI

PATHOLOGY OF GALLBLADDER AT TIME OF SECONDARY CHOLECYSTECTOMIES

(*82 Patients*)

Chronic cholecystitis without stones	34 (41%)
Chronic cholecystitis with stones	48 (58%)
Stones present in common duct	11 (13%)

TABLE XII

STENOSIS OF COMMON DUCT FOLLOWING PRIMARY OPERATION

(*Six Patients*)

	Primary Operation	Interval Since First Operation	Where Performed	Findings at Secondary Operation
1.	Cholecystectomy	17 mos.	Elsewhere	Stricture at site of ligation of cystic duct.
2.	Cholecystectomy	14 mos.	Elsewhere	Fibrous stricture of common duct.
3.	Cholecystectomy	1 yr.	Elsewhere	Fibrous stricture of common duct.
4.	Cholecystectomy	3 yrs.	Elsewhere	Fibrous stricture of common duct.
5.	Cholecystectomy	9 yrs.	Elsewhere	Dense fibrous stricture of common duct at junction with hepatic ducts.
6.	(1) Cholecystectomy (2) Choledochostomy	2 mos.	G. M. H.	Cicatrix at site of former opening in common duct.

TABLE XIII

PREVIOUS MULTIPLE OPERATIONS

(*11 Patients*)

	Previous Operations	When	Where	Final Operation
1.	(1) Cholecystostomy	8 yrs. ago	Elsewhere	Cholecystostomy; 2 wks. later cholecystectomy and choledochostomy
	(2) Chronic biliary fistula	7 yrs. ago	Elsewhere	
2.	(1) Cholecystostomy	2 yrs. ago	Elsewhere	Cholecystectomy and choledochostomy
	(2) Cholecystostomy	15 mos. ago	Elsewhere	
3.	(1) Cholecystostomy	18 yrs. ago	Elsewhere	Choledochostomy
	(2) Cholecystectomy	9 mos. ago	G. M. H.	
4.	(1) Cholecystostomy	1 yr. ago	G. M. H.	Cholecystectomy and choledochostomy
	(2) Choledochostomy	11 mos. ago	G. M. H.	
5.	(1) Cholecystectomy	3 yrs. ago	Elsewhere	Choledochostomy
	(2) Choledochostomy	10 days later	Elsewhere	
6.	(1) Cholecystostomy	2 yrs. ago	Elsewhere	Cholecystectomy
	(2) Cholecystostomy	19 days ago	G. M. H.	
7.	(1) Cholecystostomy	7 yrs. ago	Elsewhere	Cholecystectomy
	(2) Cholecystostomy	6½ yrs. ago	Elsewhere	
	(3) Cholecystostomy	6¼ yrs. ago	Elsewhere	
8.	(1) Cholecystostomy	5 yrs. ago	Elsewhere	Cholecystectomy and choledochostomy
	(2) Cholecystostomy	2 yrs. ago	Elsewhere	
9.	(1) Cholecystostomy	4½ yrs. ago	G. M. H.	Cholecystectomy and choledochostomy
	(2) Cholecystostomy	4 yrs. ago	G. M. H.	
10.	(1) Cholecystostomy	4 mos. ago	Elsewhere	Cholecystectomy and choledochostomy
	(2) Chronic biliary fistula	1 mo. ago	Elsewhere	
11.	(1) Cholecystostomy	3 mos. ago	G. M. H.	Choledochostomy
	(2) Choledochotomy	3 days ago	G. M. H.	

TABLE XIV

SEVEN PATIENTS MERELY HAVING EXPLORATIONS

1. No. 64993 Exploration. Advanced cirrhosis of liver. *Expired.*
2. No. 58728 Exploration and biopsy. Adenocarcinoma of gallbladder.
3. No. 70226 Exploration. Fibrosis and obstruction of common duct.
4. No. 82804 Exploration and biopsy. Adenocarcinoma of biliary ducts. *Expired.*
5. No. 50034 Exploration. Complete absence of common duct. *Expired.*
6. No. 52373 Exploration. Adhesions: Stenosis of common duct.
7. No. 62181 Exploration. Fibrous stenosis of common duct. *Expired.*

TABLE XV

JAUNDICE OCCURRED IN 24 (72.7%) PATIENTS FOLLOWING 33 PRIMARY CHOLECYSTECTOMIES

Operative Findings	
Dilated common duct with stones	11
Stricture of common duct	6
Dense adhesions around common duct	3
Obstruction at head of pancreas (Ca.?)	2
Carcinoma of bile ducts	1
Negative findings	1
Total	24

TABLE XVI

INCIDENCE OF PANCREATITIS

140 Patients (Present in 11.6%)

Following primary cholecystostomy	(8.7%)
Following primary cholecystectomy	(23.5%)

TABLE XVII

DEATHS (12)

Total Mortality in 140 Patients (Including Explorations for Carcinoma, etc.)
Mortality—8.5%

Age	Postoperative Day	Operation	Final Diagnosis
66	31	Choledochostomy	Subdiaphragmatic abscess and peritonitis
33	2	Cholecystectomy and choledochostomy	Uremia
60	1	Exploratory celiotomy	Cirrhosis of the liver
48	7	Exploratory celiotomy	Common duct obstruction, with hepatic insufficiency
57	7	Cholecystectomy and choledochotomy	Cardiac failure
46	7	Choledochostomy	Hemorrhage; shock
56	1	Cholecystectomy and choledochostomy	Shock
58	1	Choledochostomy	Suppurative cholangitis; acute hepatitis; acute toxic nephritis
51	1	Cholecystectomy	Hemorrhage; shock
63	5	Cholecystectomy and choledochostomy	Acute peritonitis; acute cholecystitis
43	9	Exploratory; biopsy	Adenocarcinoma of biliary duct
51	2	Exploratory celiotomy	Stenosis of common duct

TABLE XVIII

CAUSES OF DEATH OF PATIENTS HAVING SECONDARY OPERATIONS ON GALLBLADDER AND DUCTS

(Excluding Seven Patients upon whom merely explorations were carried out—carcinoma, etc.)
Mortality—6.4%

Operation	Cause of Death
1. Choledochostomy	Subdiaphragmatic abscess with peritonitis
2. Cholecystectomy and choledochostomy	Uremia
3. Cholecystectomy and choledochostomy	Cardiac failure
4. Choledochostomy	Hemorrhagic shock
5. Cholecystectomy and choledochostomy	Common duct obstruction; hepatic insufficiency
6. Cholecystostomy	Suppurative cholangitis; acute hepatitis
7. Cholecystectomy	Postoperative hemorrhage
8. Cholecystectomy and choledochostomy	Acute cholangitis; acute peritonitis
9. Exploration	Adenocarcinoma of biliary ducts.

TABLE XIX

MORTALITY

	Mortality Percentages
Hospital mortality—Total for entire series (140 patients) having secondary operations	8.5%
Eliminating seven explorations for inoperable carcinoma; hopeless destruction of ducts, *etc.*, but including all patients having secondary operations upon gallbladder or ducts	6.4%
Mortality following 25 secondary combined cholecystectomies and choledochostomies	4.7%
Mortality following 66 secondary cholecystectomies	1.5%

Weir and Snell,[22] of the Mayo Clinic, attribute persistence of symptoms following cholecystectomy, to errors in diagnosis and poor selection of cases; to residues of cholecystic disease such as cholangitis, hepatitis and pancreatitis; to stricture formation in extrahepatic bile passages; and to visceromotor disturbances, such as biliary dyskinesia. In discussing errors in diagnosis at the time of the primary operation they mention, as factors most commonly overlooked, peptic ulcer, appendicitis, pylorospasm, renal lesions and tabes dorsalis. Conditions commonly simulating jaundice mentioned by these authors were intrahepatic lesions and hemolytic states giving an indirect van den Bergh reaction. Familial or congenital hyperbilirubinemia and pernicious anemia were also referred to. Next to primary diagnostic errors, the commonest cause of symptoms necessitating secondary operations were residual changes in the bile ducts, secondary hepatitis, or pancreatitis.

Obviously, overlooked common duct stone is one of the most frequent causes of postoperative symptoms, while a second, equally important factor, is persistent cholecystitis following an incomplete cholecystectomy.

Walters[19] has called our attention to the extremely bizarre and atypical colics, often with absence of jaundice, occurring when overlooked common duct stones are present. Walters[20] as Lahey[15] and other recent writers, has dealt exhaustively with the subject of diagnosis and treatment of postoperative stricture. Clute[5] recently stated that "an accurate estimate of the relative value of the various operations for the relief of this serious condition is yet difficult." As will be recalled, Walters[19] reported, three years ago, 51 cases of his own, and quoted Lahey's comparative study of a number of cases of stricture treated by different methods—a clinical study of the greatest interest, and one throwing much light on the relative effectiveness of a number of procedures. Most authors who have written on the subject of secondary operations for the removal of common duct stones refer to 10–50 per cent incidence of an associated pancreatitis.

Walters[20] presents a summary of the experience at the Mayo Clinic with secondary operations upon the bile ducts, performed for stricture. Eighty patients were operated upon, with a mortality of 12.5 per cent. Fifteen of the 80 patients (18 per cent) have died since their operations, and the remainder have been well and without evidence of gross obstruction.

Hermanson[8] has stated that the presence of calculi in the common duct following a cholecystectomy results from: (1) Formation of stones in the hepatic and common ducts. (2) Descent of intrahepatic stones. (3) Escape of stones from the gallbladder into the common duct at the time of the first operation. (4) Overlooking the stones at the first operation.

One of the most complete studies of the subject was presented before this Association last year, by Heyd,[9] a paper of unusual interest, not only for its scientific scope but for the extraordinarily complete statistical analyses it contained. On that occasion the author described 68 patients who had had a previous cholecystostomy and who had a subsequent cholecystectomy, with a mortality of 7.4 per cent, and also 39 cases of previous cholecystectomy now having a choledochostomy, with a mortality of 40 per cent. Heyd made a plea for more frequent primary exploration of the common duct.

Among 426 cases of gallbladder disease reported by Cheever,[4] there were 31 secondary cholecystectomies following cholecystostomies. The common duct was explored in 37 per cent of 426 operations, with calculi being found in 44 per cent in the cases of common duct exploration.

Walters and Comfort[21] give the incidence of common duct stones as 12.19 per cent, while Lahey[14] reports exploring the common duct in 44 per cent of his cases and finding stones in 18 per cent.

Cole[16] has informed us that 1.8 per cent of patients having had a cholecystectomy return for operation, while 24 per cent of those who have had the gallbladder merely drained, require secondary procedures. He refers to Cave's report of 86 per cent of his patients being well following cholecystectomy, while 56 per cent of a series of patients upon whom cholecystostomies had been performed were compelled to return for reoperation.

Danzis[7] gives a figure of 32 as the percentage of patients having had cholecystostomies who will require secondary operations.

Kunath[13] states that 40 per cent of patients having gallbladder drainage usually have recurrence of symptoms in from one month to three years later, and that 17 per cent required a secondary cholecystectomy. The figure is given by Judd and Priestly[12] as 17 per cent.

Judd and Phillips[11] described eight cases of acute perforation of the gallbladder occurring some years following cholecystostomy.

Heyd[10] found common duct stones in 80 per cent of the patients having secondary operations following cholecystectomies. He also found that the mortality risk inherent in common duct surgery is three times that of simple, uncomplicated cholecystectomy.

Beye[2] reported his experience with 66 patients requiring secondary operations. Of this group, 14 were reoperated upon because of "reformed" gallbladders (dilated cystic duct stumps); 11 because of injury to the major ducts; six because of common duct stones; and two because of angulation of the common duct. While several authors have referred to dilated residual cystic duct stumps following cholecystectomy, such conditions have been rarely found in the present author's experience, and are not considered as frequent causes of postoperative symptoms.

PREVENTION OF SECONDARY OPERATIONS

A study of patients upon whom secondary operations become necessary, leads one to conclude that the most important single factor in the prevention of later trouble is to arrive at the primary diagnosis early; to operate as soon as the diagnosis is clearly made; and, above all else, to perform a *complete* operation at the first sitting. Almost invariably, this means a cholecystectomy, with complete avoidance of injury to the hepatic and common ducts, and with routine exploration of the latter if it is dilated, if stones are palpated

within it or if the clinical history and laboratory findings in any way suggest the presence of common duct calculi. Secondary operations become necessary, usually, because a drained gallbladder has been permitted to remain; because the common duct has been seriously traumatized; or because stones in the hepatic or common ducts have been overlooked. A few have to be performed because of reformation of common duct or gallbladder stones or because of neoplastic processes, overlooked at the first sitting, or having subsequently developed.

I have not referred to roentgenographic examination carried out during exploration of the common duct. I feel it to be of value, yet possibly too cumbersome and time-consuming a procedure to be entirely or, at least, routinely practicable. Of far more importance, it seems to me, is a most thorough exploration of the ducts, using the best of the instruments which have been devised for this purpose, among which nothing quite equals Desjardin's scoop. With adequate exposure, able assistance, and appropriate armamentarium, the surgeon, in nearly every instance, should be able to assure himself that the ducts are empty, and that adequate drainage through the ampulla has been completely established. In this, he may be aided by dilating the ampulla as proposed by Cheever,[4] or by resorting to the use of the Bakes' dilators, the value of which has been demonstrated by Allen and Wallace.[1] It must be borne in mind, however, as has been pointed out by many writers, that the advantages of this procedure may be outweighed by its inherent dangers, unless it is expertly and painstakingly employed. In the early postoperative period cholangiography is of value in revealing the degree of patency of the duct and ampulla.

One is impressed by the number of instances when findings, at secondary operations, are surprisingly slight and so out of keeping with the severity of the symptoms as to leave one baffled in attempting to account for them. As an example, eight patients were deeply jaundiced and yet had no common duct stones. Also, among 33 patients upon whom a cholecystectomy had previously been performed and who suffered from typical symptoms of severe biliary colic, there were 22 whose common ducts, at the second operation, were found empty.

Cholecystitis is a continuous and progressive condition, rarely self-limiting; its gradual and inexorable progress extending with the passage of time from the gallbladder to the ducts, to the liver, and to the pancreas. A recent study made by Heyd[9] revealed that patients having symptoms less than two years have stones in the common duct in 2 per cent, those with symptoms two-ten years, in 9 per cent, and those with symptoms over ten years, in 16 per cent. Complications and ultimate mortality increase proportionately with the duration of the disease, its curability becoming less possible the longer the patient is permitted to suffer from it. Let our medical confreres, and the gastro-enterologists who may be prone to treat the condition with remedial measures other than surgery, take note.

"NONCALCULOUS" CHOLECYSTITIS

While no one will question the advisability of surgical treatment once the diagnosis has been clearly established, one cannot but look with serious question upon statistics that, from time to time, have appeared, in which a considerable proportion of the diagnoses have been "noncalculous cholecystitis" or "mild chronic cholecystitis" or perhaps simply "cholesterosis." In a number of recent contributions, these classifications have constituted from 30 to 40 per cent of the entire series reported, and while they help to render the presentation impressive and are usually associated with a praiseworthy mortality of but 1 or 2 per cent, one has difficulty in being convinced other than that many of the operations were performed because of *symptoms* rather than because of definite pathologic processes which would justify the performance of a cholecystectomy. In a recent paper relative to a series of patients having had cholecystectomies, 44 per cent were reported as having had no stones. In another recent report, in which a large collected series of cases is analyzed, 21 per cent of the patients were recorded as having merely "mild cholecystitis." In still another series of 500 cholecystectomies but 40 per cent of the patients had stones. Still in another study of a collected series of several thousand patients, operated upon by many surgeons, the percentage of those patients having no stones was 31. Years ago, W. J. Mayo[16] stated that, "the milder degrees of cholecystitis, when subjected to operation, will not present a high percentage of cures, and should usually be considered medical rather than surgical problems." As Barney Brooks and Wyatt,[3] in their fascinating historical essay, have remarked: "Whether or not disagreeable symptoms may come from an alteration in the function of the gallbladder without anatomic change and, if so, whether these symptoms can be relieved by extirpation of the gallbladder, are unsolved problems of gallbladder disease."

There have been frequent comments from internists concerning poor results following cholecystectomy. They will continue to be warranted as long as the number of operations performed on gallbladders, with but slight or no evidence of disease, remains as high as it is at present. In studying the literature of cholecystitis, one may be disturbed by a mortality figure exceeding 6 or 7 per cent. One may, also, by the same token, be logical in questioning the justification of performing the cholecystectomies when, in a given series, the author reports a mortality much under 2 per cent. Stanton[18] in 1932, remarked "just so far as the clinical picture of true biliary colic becomes doubtful, or the clinical picture shades over into ill-defined digestive disturbances, that many surgeons have been wont to call the symptoms of the 'precalculous' stage of cholecystitis, do the end-results of operative treatment begin to fail."

That the majority of individuals past middle life will show some pathologic change in the walls of the gallbladder, was stressed before our Association last year by Parsons,[17] who added that "operations performed for mild

or nonexistent gallbladder disease, or for simple physiologic disturbances will yield universally poor results." With this we are in full agreement.

One might speculate as to what would have occurred had no operation been performed, possibly assuming that a more serious process would have appeared with the passage of time and that the cholecystectomy was justified as a prophylactic measure, if for nothing else. One might even support this contention with a positive cholecystogram. We cannot, however, but be of the conviction that when confronted with a patient presenting indefinite symptoms, that, with Hamlet, "we should have grounds more relative than this," before routinely removing a gallbladder in connection with which no possible diagnosis can be made other than chronic noncalculous cholecystitis.

The patients upon whom, in the past, we have performed cholecystectomies for symptoms, and who did not have stones and whose gallbladders revealed but little other than that discernible to the microscopic eye of a sympathetic pathologist, have usually been made worse. We learned that lesson years ago. Of the last 500 patients upon whom we have performed cholecystectomies, 92.6 per cent had stones. Walters[19] reports the percentage at the Mayo Clinic as being approximately the same. In their 1938 series, stones were found in 89 per cent of all the patients having cholecystectomies.

In short, yet with certain well-defined reservations, we question the identity of that pathologic vagary, usually referred to as chronic, noncalculous cholecystitis. Not that the definitely diseased gallbladder containing no stones should not be removed, but that, while the patient whose gallbladder contains calculi, obviously suffers from an entity calling for its eradication, the patient having a cholecystectomy for alleged chronic noncalculous cholecystitis may prove to be the victim of too great surgical zeal rather than the beneficiary of sound surgical judgment. Under such circumstances not only may he fail to obtain any benefit from the procedure but, as is frequently the case, may be started on a career of interminable rehospitalizations for the relief of symptoms resulting from injury of the common duct. Many of the patients referred to us for secondary operations have previously had cholecystectomies for "chronic cholecystitis without stones," the present symptoms, rather than manifestations of actual disease *per se* being the sequelae of surgical operations performed for the relief of symptoms erroneously assumed to be due to pathologic processes involving the biliary system.

POSTOPERATIVE HERNIA

A common, extrinsic, cause of trouble following operation upon the gallbladder and biliary tract, which may appropriately be mentioned at this time, is incisional hernia. It is referred to particularly, for the reason that the author, after closing thousands of abdomens by every conceivable method, finds his present technic so satisfactory, and wound healing so incomparably better than he has been able to obtain before. For the past six months all abdominal incisions have been closed, with a single strand of continuous catgut in the peritoneum, followed by, and this is the crux of the whole

matter, a series of closely spaced interrupted sutures of No. 30 white sewing cotton, in the deep and superficial rectus sheaths. Dead spaces in the fat are obliterated by a few interrupted sutures of cotton, and the skin approximated with interrupted sutures of the same material. No stay sutures, of any kind, are ever used. There have been no postoperative herniae, no disruptions, and no sinuses, except in primarily infected cases. If the reader is skeptical let him try the method and be convinced, as he is bound to be. Just why cotton is, in all probability, one of the best suture materials available to us, although it has reposed in our wives' sewing baskets for years without our being aware of its worth, has been adequately set forth by Mead and Ochsner.[23]

CONCLUSIONS

(1) An analysis is presented of 140 patients requiring secondary operations among 2,485 treated by the authors for biliary tract disease.

(2) Secondary operations become necessary largely because of incomplete procedures at the time of the primary celiotomy, or to traumatism of the hepatic ducts at that time.

(3) The number of gallbladders, containing no stones and, possibly, the site of no disease, being removed because of suggestive symptoms, is unquestionably too high, and is one of the direct causes of symptoms necessitating secondary operations for their relief.

(4) While many patients, following cholecystectomy, may suffer from characteristic symptoms of biliary colic, secondary explorations of the biliary system may, in a large proportion, fail to reveal any process to adequately explain the symptoms.

(5) Cholecystic disease is a constantly progressive one, readily curable in its incipiency but one prone, with the passage of time, to produce serious and often fatal complications. The longer the delay the more serious becomes the operation and the greater likelihood of secondary operations becoming necessary.

(6) Treatment should be carried out early. It should always be surgical. To temporize with other means is dangerous and unjustifiable.

(7) The first operation must be a complete one, one painstakingly conducted, with extirpation of the gallbladder in nearly every instance, and with the thorough removal of all stones wherever they may be.

REFERENCES

[1] Allen, A. W., and Wallace, R. H.: Technic of Operation on the Common Bile Duct; With Special Reference to Instrumental Dilatation of the Papilla of Vater. Am. Jour. Surg., 28, 533–561, 1935.

[2] Beye, H. L.: Conditions Necessitating Surgery Following Cholecystectomy. Surg., Gynec., and Obstet., 62, 191–202, 1936.

[3] Brooks, Barney, and Wyatt, Thomas E.: Surgery of the Gallbladder. ANNALS OF SURGERY, 109, 334–350, 1939.

[4] Cheever, D.: Methods and Results in Surgical Treatment of Diseases of Biliary Passages. New England Jour. Med., 213, 463–470, 1935.

[5] Clute, H. M.: Operative Procedures in Common Duct and Hepatic Duct Injuries. New England Jour. Med., 206, 47–51, 1932.
[6] Cole, W. H.: Factors in Prognosis and Mortality of Gallbladder Disease. Internat. Abstr. Surg., 69, 40–46, July, 1939.
[7] Danzis, M.: Analysis of 250 Cases of Gallbladder Operations. Jour. Med. Soc. New Jersey, 25, 642–645, 1928.
[8] Hermanson, L.: Occurrence of Common Duct Stone Following Gallbladder Operations. New England Jour. Med., 211, 806–880, 1934.
[9] Heyd, Charles: Factors in Mortality in 4,000 Operations Upon the External Biliary System. ANNALS OF SURGERY, 111, 820–831, 1940.
[10] Heyd, Charles, Carter, R. Franklin, and Hotz, Richard: Surgery of the Biliary Tract. Am. Jour. Surg., 44, 679–687, 1939.
[11] Judd, E. S., and Phillips, J. R.: Perforation of Gallbladder in Acute Cholecystitis. ANNALS OF SURGERY, 98, 359–361, 1933.
[12] Judd, E. S., and Priestly, J. T.: Ultimate Results from Operations on the Biliary Tract. J.A.M.A., 99, 887–891, 1932.
[13] Kunath, C. A.: Treatment of Acute Cholecystic Disease. Surg., Gynec., and Obstet., 65, 79–87, 1937.
[14] Lahey, F. H.: Discussion. J.A.M.A., 99, 894, 1932.
[15] Lahey, F. H.: Strictures of the Common Duct and Hepatic Ducts. ANNALS OF SURGERY, 105, 765–786, 1937.
[16] Mayo, W. J.: Quoted by Walters and Snell, Diseases of Gallbladder and Bile Ducts. Philadelphia, W. B. Saunders Co., 1940, p. 366.
[17] Parsons, Willard: The Immediate and End-Results of Cholecystectomy. ANNALS OF SURGERY, 111, 831–838, 1940.
[18] Stanton, E. MacD.: The Stoneless Gallbladder. Am. Jour. Surg., 18, 246-250, 1932.
[19] Walters, Waltman: Recent Advances in Surgical Treatment of Lesions of Biliary Tract. Surgery, 3, 786–798, 1938.
[20] Walters, Waltman: Strictures and Injuries of the Bile Ducts; Study of Results of Operations in 80 Cases. J.A.M.A., 113, 209–213, 1939.
[21] Walters, Waltman, and Comfort, M. W.: Difficult Problems Encountered in Surgery of the Biliary Tract. South. Clin. North America, 18, 1083–1101, 1938.
[22] Weir, James F., and Snell, Albert M.: Symptoms that Persist after Cholecystectomy —Their Nature and Probable Significance. J.A.M.A., 105, 1093–1098, 1935.
[23] Meade, William H., and Ochsner, Alton: The Relative Value of Catgut, Silk, Linen, and Cotton as Suture Materials. Surgery, 7:485–514, 1940.

ACUTE CHOLECYSTITIS WITH PERFORATION INTO THE PERITONEAL CAVITY*

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PERFORATION of the gallbladder is referred to in most text-books on surgery as a rare complication. This statement is true only if it is considered in relationship to all cases of gallbladder lesions which come to our attention. It is common knowledge that it occurs in from 1 to 2 per cent of chronic cholecystitis.

We are interested especially in the percentage of perforations found as a complication of acute cholecystitis, and herein report 21 cases which have occurred in two hospitals in Baltimore, Md.

Perforations complicating chronic cholecystitis usually lead to abscesses about the gallbladder, the infection being "walled-off" by the adjacent colon, omentum, duodenum, and liver, and frequently lead to fistulae into the colon or duodenum, and to burrowing infections in the abdominal wall or to the subphrenic space. Perforations complicating acute cholecystitis cause a diffuse biliary peritonitis which is highly toxic, and against which the peritoneum has little defensive powers. It is with the latter group, where perforation occurs into the free peritoneal cavity, that this report is concerned.

The records of two hospitals, namely, the Church Home and Infirmary, and the University Hospital, have been studied. The cases have been under several of the surgeons of the two institutions. We believe, therefore, that this report is suggestive of the actual percentage of perforations into the peritoneal cavity which might generally be anticipated.

During the years 1929 to 1939, inclusive, at the Church Home and Infirmary, there were 32,921 admissions, of which 531 were cases of gallbladder disease, or 1.6 per cent of the total. Of the 531 cases of cholecystitis, 435 were chronic, and 96 were acute. In this latter group there were eight perforations into the peritoneal cavity, or 8.33 per cent.

In the years 1934 to 1939, inclusive, at the University Hospital, there were 34,958 admissions, of which 593 were cases of cholecystitis, or 1.7 per cent. These are divided into 496 chronic and 98 acute. In the latter group there were 13 perforations into the peritoneal cavity, or 11.5 per cent.

Therefore, in the combined groups we have 194 cases of acute cholecystitis, proven either by operation or postmortem, in which perforation occurred into

* Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

the peritoneal cavity in 21 patients, a percentage of 10.82. Surely, therefore, this serious complication cannot be regarded as rare.

It is conceded by surgeons in general that patients with chronic cholecystitis may have their operation deferred while being thoroughly studied and prepared, but this policy of watchful waiting cannot be applied to the acute case with any degree of safety. This observation is clearly illustrated by the fact that only six of the eight cases of the Church Home group could be operated upon, although the length of illness prior to admission was short. The other two cases were practically moribund when admitted to the hospital; they failed to respond to treatment and succumbed to the overwhelming infection and toxemia. Therefore, only 75 per cent of this group were operable. In the remaining two cases the diagnosis was confirmed by postmortem examination.

In the University Hospital group, 12 of the 13 cases were operated upon. The remaining case, a female, age 68, who had been ill less than 24 hours before admission, was unable to endure an operation. She failed to respond to treatment and succumbed less than 18 hours after admission. A postmortem examination revealed a perforation at the fundus of the gallbladder with generalized, purulent, bile-stained peritonitis.

In the Church Home group of six operated cases, there was one death, or 16.66 per cent. In the University Hospital group of 12 operated cases, there were two deaths, or 16.66 per cent. Only one of these two fatal cases came to postmortem. A male, age 59, who had suffered severe upper right quadrant pain on frequent occasions during the previous several years. He had noted continuous pain for more than 24 hours before being referred to the hospital. On admission, he was critically ill, vomiting, distended; his skin was dry, and jaundiced, and the abdominal muscles were fairly rigid throughout. Tenderness was exquisite and diffuse, and there was a mass in the upper right quadrant. On exploration, the hepatic flexure of the colon was found to be densely adherent to the gallbladder, and obstructed. A perforation of the gallbladder had occurred just lateral to its fixation to the colon. Gallstones and bile were found in the free peritoneal cavity. Upon separating the gallbladder from the colon the obstruction to the latter was immediately overcome. The gallbladder was removed. The common duct was so edematous that it could not be palpated satisfactorily, and its exploration by sounding or open operation was regarded as unwise. The patient responded fairly well until the eleventh day when his wound disrupted. This was closed, under local anesthesia, with silver wire sutures, but the patient died two days later of bronchopneumonia. A postmortem examination revealed suppuration and calculous deposits in the ducts within the liver, and one smooth, dark stone in the terminus of the common duct.

Bacteriologically, nothing new or unexpected has been noted in this series of cases. The colon bacillus has been recovered from the gallbladder in six cases, Streptococcus fecalis in one case; Streptococcus nonhemolyticus

in one case, and Staphlylococcus aureus in one case. No growth was recorded in four cases, and no culture was made in the remaining eight cases.

The most recent case in the University Hospital group is of particular interest, because the patient had been discharged from the hospital less than three weeks, having just recovered from a ulceroglandular type of tularemia, and while in the hospital, and being treated for tularemia, had a severe attack of cholecystitis, from which she slowly recovered. She was readmitted, March 9, 1939, for acute cholecystitis. The patient was critically ill, but because of her recent experience, and because she was being held over for material needed at an exhibition clinic, the operation was postponed. She seemed to improve, and on the day of the clinic, March 15, 1939, less than one hour before the operation was to be performed, she complained of a sudden, severe pain over the entire abdomen. Upon opening her abdomen a perforation, 2 cm. in diameter, was found in the fundus of the gallbladder, with stones and bile floating in the peritoneal cavity. Bile from the gallbladder and sections of the gallbladder wall were studied in the laboratory of the State Department of Health, and in our own laboratory for any evidence of tularemia, but none was found.

No attempts have been made in these cases to find any pancreatic enzymes, and while the regurgitation of pancreatic and duodenal juices into the gallbladder is possible under some circumstances, it is inconceivable, in view of the pathology encountered in the biliary system in the cases being considered.

The leukocyte count in the majority of our cases has averaged from 18,000 to 20,000, but no other laboratory test has been of consistent value in determining the severity of the infection and inflammation. Febrile reaction and pulse rate have been quite variable. Roentgenograms have played no part in arriving at a diognosis in these cases. The history, in all, has been so suggestive of gallbladder disease that, as usual with this type of case, it has been dependable, and we believe that roentgenograms have no place in the diagnosis of acue cholecystitis, with or without impending perforation.

What, then, should one depend upon in order to make a diagnosis? We believe that the diagnosis of an acute cholecystitis can be accurately enough approached if based upon a carefully taken history, and an equally complete physical examination.

The exquisite tenderness on the slightest pressure over the gallbladder region is indicative of peritoneal irritation, and if this same condition is noted over the entire abdomen it certainly suggests a rapidly spreading biliary peritonitis. If, following the administration of glucose and salt intravenously, the patient looks better and feels better, but shows no, or very little improvement locally on palpation of the right upper quadrant, an immediate operation is indicated.

The particular operation performed has largely been governed by circumstances. Most of the surgeons have favored cholecystectomy, but have been forced to perform a cholecystostomy or a partial resection of a gangrenous

gallbladder on occasion. There have been ten cholecystectomies, seven cholecystostomies, and one partial resection of the gallbladder.

Ten years ago the senior author changed his opinion regarding the advisability of waiting for the acute cholecystitis to subside, and has never regretted this change of attitude. Increasing experience with these cases justifies the present conviction that acute cholecystitis is an abdominal emergency requiring immediate surgical intervention.

CONCLUSIONS

(1) Perforation into the free peritoneal cavity as a complication of acute cholecystitis is not rare. It has been observed in 10.82 per cent of our cases.

(2) It occurs with or without bacterial invasion of the gallbladder.

(3) It occurs with or without gallstones.

(4) It initiates a severe chemical peritonitis, which is highly toxic.

(5) Early operation is indicated.

(6) Diagnosis of perforation is difficult to make, except at operation, but the decision of when to operate must be based chiefly upon clinical observation.

DISCUSSION.—DR. THOMAS S. CULLEN (Baltimore, Md.): Doctor Edwards has given us a most interesting paper on cases of acute inflammation of the gallbladder in which perforation into the free abdominal cavity has taken place. Let me go a step further and briefly relate two cases in which perforation of the gallbladder occurred and in which, at the time, no operation was performed.

Case 1.—Church Home and Infirmary No. 2961: Mrs. H. R., age 61, a patient of Dr. James H. Preston, of Hamstead, Md., was admitted to the Church Home and Infirmary, January 29, 1909, as an emergency. Fifteen years before, she had had pain in the region of the liver and her physicians thought she was going to die.

For 48 hours before I saw her she had been complaining of pain in the region of the appendix and had had some elevation of temperature. The pain was so severe that immediate operation was undertaken. A gridiron incision was made and the appendix was removed; this, however, showed little gross pathology. The tip of the omentum was adherent to a pedunculated, calcified myoma of the uterus, 1.5 cm. in diameter. The myoma was removed.

A hand carried into the right upper abdomen revealed adhesions; consequently, we made an upper right rectus incision. Doctor Preston said: "Fifteen years ago, when the patient nearly died, I diagnosed rupture of the gallbladder but the consultants only laughed at me and said such a thing was impossible."

Lying outside of and to the right of the gallbladder, and in no way connected with it, were about eight small, faceted gallstones. I tried to pick them up with forceps but they were covered by transparent adhesions. I split the adhesions over each with a knife and shelled them out. They reminded me of glacé nuts which have a thin, smooth covering of candy. There were dense adhesions between the duodenum and the gallbladder which was everywhere intact. The gallbladder contained several stones. These were removed and the gallbladder was drained.

The patient made a satisfactory recovery and was discharged February 17, 1909.

Case 2.—C. H. I., No. 49279. Mrs. E. B. J., age 52, was referred to me by Dr. Thomas R. Boggs. She complained of drowsiness and headache, and of spells of in-

definite pain in the right upper abdominal quadrant. She had had attacks similar to the present illness, on and off, for the past 30 years, and had had pain in the gallbladder region accompanied by jaundice and clay-colored stools. Her worst attack occurred about three years before I saw her.

At operation, April 29, 1929, the appendix was found to be twice its natural size in its distal portion; it was removed. The edge of the gallbladder projected above the edge of the liver, and we could see a small pile of gallstones situated on the top of the viscus, but snugly bound down by adhesions. The gallbladder, which was packed full of stones, was removed (Fig. 1). The patient was discharged June 8, 1929.

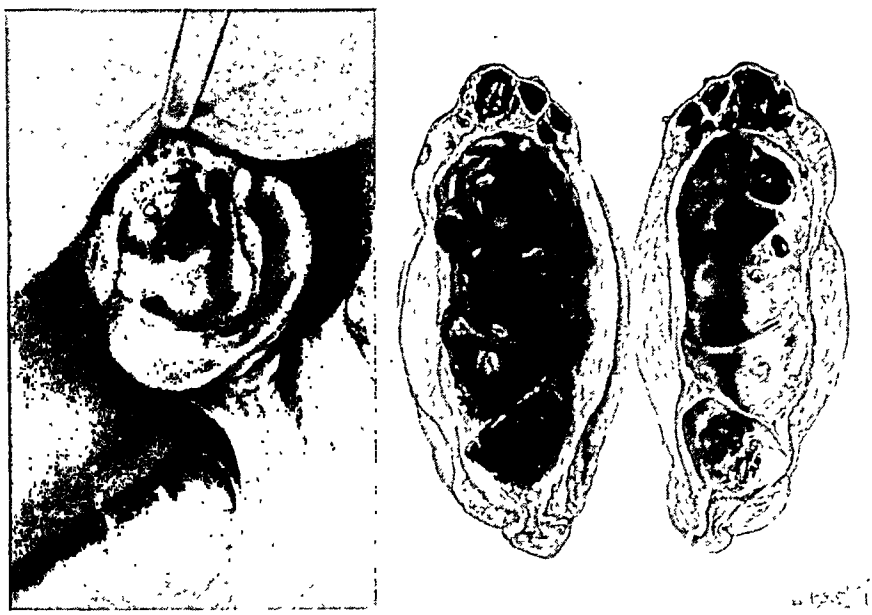


FIG. 1.—Appearance of the gallbladder approximately three years after rupture, and where no operation was performed at that time.

The gallbladder projects slightly above the edge of the liver. On its surface are numerous small, very dark-colored gallstones, and lower down, on the outer surface of the gallbladder are two small stones.

On opening the gallbladder, numerous stones are seen lying on top of the viscus but held to its surface by old adhesions. They are entirely outside of the gallbladder.

The gallbladder itself is packed full of gallstones. These vary in size, some are large, others very small.

The gallbladder is somewhat sacculated.

She was readmitted to the Church Home and Infirmary November 3, 1938. The diagnosis at that time was: Arteriosclerotic heart disease; hypertensive cardiovascular disease; and hypertrophic arthritis. There were no symptoms referable to the right upper quadrant.

The patient came in to see me to-day (December 27, 1940) and looks unusually well.

In the first case, rupture of the gallbladder undoubtedly occurred 15 years before my operation; the rupture of the gallbladder in the second case probably took place three years before we operated. It is certainly remarkable what nature alone can do in some cases.

DR. CHARLES GORDON HEYD (New York, N. Y.): I should like to speak first on the paper of Doctor Foss. You must recognize that gallbladder disease is a continuing pathologic change, and if and when a patient reaches the point when the cystic duct, common duct, pancreas and liver are involved, it is very doubtful if any surgical procedure would render that patient symptomless. In other words, we must view the totality of symptoms and pathologic changes in gallbladder disease.

In a series reported before this Association last year, it was demonstrated that in 4,000 operations for gallbladder disease, 69 per cent of the patients had chronic cholecystitis, characterized by calculi, and what is of great interest is that 6 per cent of the patients had a cholecystectomy without having calculi in the gallbladder but having calculi in the common duct. In 3,240 patients in whom a cholecystectomy was performed, the common duct was explored in 7 per cent; in the 7 per cent, 238 cases, calculi were found in the common duct in 86 per cent, with a mortality of 11 per cent. Sixty-eight patients had had a previous cholecystostomy for chronic cholecystitis and returned later for a cholecystectomy, and the mortality was 7.4 per cent, or exactly double a *primary* operative mortality for cholecystectomy. These patients had a double death-hazard in the second operation, as contrasted with the first.

Exploration of the common duct, after a previous cholecystectomy, was performed in 39 patients, with a mortality of 40 per cent; of these 39 patients, 33 of the operations were performed elsewhere than at the Post-Graduate Hospital, and of the 39 patients, 32 had recurrent, or overlooked, common duct calculi, and seven had a stenosis of the common duct. In 54 per cent of the patients with cholecystostomy that could be traced and were subsequently operated upon, 77 per cent had recurrent, or overlooked, calculi.

In 574 cases of acute cholecystitis, calculi were present in the gallbladder in 89 per cent; and calculi were present in the common duct, associated with acute cholecystitis, in 17 per cent of the cases. Therefore, if these statistics represent anything, it is that the first operative intervention for disease of the gallbladder should be as thorough and as complete as possible, as secondary operations in disease of the biliary system are characterized by such a high rise in mortality rate.

Referring to the paper of Doctor Edwards: it is rather surprising to note how many excellent physicians believe that acute cholecystitis is a condition that should be left alone, and the patient will recover, except for a few occasions of accidental perforations. This assumption is not warranted by an objective survey of the statistical material in our hands. In 3,986 operations for gallbladder disease of all kinds and types, perforation was found in 3 per cent of the total number, and in 574 cases of acute cholecystitis, perforation occurred in 69, an incidence of over 12 per cent. Of these 69 cases, there was perforation with local abscess in 18, perforation with peritonitis in 46, and perforation with pancreatitis in seven. Seventy-seven per cent of all cases with perforation had a peritonitis, and 60 per cent had a diffuse peritonitis. In other words, only 23 per cent of the patients with perforation had sufficient peritoneal protection to "wall-off" the perforation in the gallbladder, with the formation of a localized abscess.

Of even more importance is the fact that if the patient, by luck and Providence, recovers from an attack of acute cholecystitis, the mortality at the time of a second operation is, in every category, a pathologic change *double* that which occurs in the *primary* operative group. The term "immediate operation" is, in my opinion, not applicable to gallbladder surgery. In our experience, patients with acute cholecystitis that were operated upon as "emergency cases," within one to six hours after admission to the hospital, had a mortality of 14 per cent. If, however, these patients were treated in the hospital for 24 hours—largely overcoming dehydration—the mortality was reduced to 7 per cent.

DR. ROBERT L. RHODES (Augusta, Ga.): Three years ago, at the Birmingham meeting, I discussed this subject. I paraphrased the old saying that the operation was a success but the patient died, by saying that with

biliary work the operation was a success but the patient continued to suffer. We might summarize some of the points by saying that in many cases careful blood chemistry studies, pre- and postoperative, would throw light. Oftentimes a patient with an acute gallbladder might have blood chlorides as low as 200, and if he were operated upon then, he would die. There is another group with high uric acid content, and they would certainly burn up in rapid order.

I worked out for myself the thought that the gallbladder is a mirror as to what is in the liver behind it. Doctor Foss made the point of the relationship of the gallbladder to the liver, infection getting into the liver from the gallbladder, *etc.* I feel that it is the other way around, that infection has got into the lymphatics of the liver, thence into those of the gallbladder, and just so badly diseased as is the gallbladder, so also is the liver behind it. Doctor Lahey, this morning, said that surgeons must learn to think and act for themselves, and that is true. The surgeon must decide. In postoperative follow-up medical men will not cooperate, and, as a consequence, I have not turned loose a gallbladder case in less than 12 months for the past 15 years. Why? Because people have forgotten how to eat! How many people live on cold drinks and sandwiches at the drug store? They have burned their "doggoned" livers out, and if we do not teach them to get off that high acid-ash diet there is sure to be a continued acidosis. As shown by Doctor Foss, a certain percentage of patients will come back, and oftentimes a second operation will not show stones or explain the trouble, but if you bear in mind the problem of metabolism and elimination, and outline a carefully balanced diet, with an abundance of fluids, you will find you have much happier results in gallbladder work.

Dr. Howard M. Clute (Boston, Mass.): Doctor Foss touched briefly on the difficulties presented by strictures of the common bile duct, and I am sure we are all familiar with the complicated technical problem that these cases present. Dr. Herman E. Pearse, of Rochester, N. Y., has devised a Vitallium tube for implanting in the strictured common duct, and he has had two successful cases in which it was used. Through his courtesy, I have obtained some of these Vitallium tubes. Recently, I operated upon a woman whose common duct had been destroyed at its upper end, and connected the tiny remnant of common hepatic duct to the common duct by a Vitallium tube. Thus far she has remained perfectly well.

I wished to give you this early report on this method in the hope that this new procedure of Doctor Pearse's may prove as useful to some of you as it has to me, in these very trying strictures of the common duct.

Dr. George H. Bunch (Columbia, S. C.): In discussion of Doctor Edwards' paper, I would like to say that infection, obstruction and change in chemical composition of bile from metabolic dysfunction are the three most common causes of cholecystitis and stone formation. By preventing stasis, better muscular development and the necessity for doing physical work are material factors in the comparatively small incidence of gallbladder disease in males as compared to females. This also explains the low incidence of gallbladder disease in the Negress.

Orthopedic immobilization, by limiting abdominal movement, may induce bile stasis to a superlative degree. We wish to report two cases in which acute exacerbation of chronic gallbladder infection took place while the patients were being treated for fractured femur.

Case 1.—A white male of average size, age 38, who had been in a body encasement for several weeks for fracture of both femora, developed acute pain in the upper ab-

domen with fever and leukocytosis. He had previously been in good health. On the second day after onset, an exploratory celiotomy was performed through an extension of the window in the double spica. There was found an acute perforation of a gangrenous gallbladder, with extravasation of bile into the free peritoneal cavity, and a single non-faceted stone, the size of an acorn, extruded from the gallbladder. The gallbladder was removed, the bile mopped out of the abdomen, and the wound closed, with drainage. The body encasement was not disturbed. He recovered.

Case 2.—An obese white female age 60, while confined to bed with her leg immobilized in a Thomas splint, developed an acute infection of the gallbladder. At celiotomy the gallbladder, containing faceted stones, was found to be gangrenous but not ruptured. She recovered after cholecystectomy.

DR. FRANK H. LAHEY (Boston, Mass.): There are two points I would like to make. I sent telegrams to two patients who had had strictures of the common duct, in whom I had implanted rubber tubes. One wire was sent to a man in Williamsport, Pa., who had been operated upon four years ago. His reply was that he had not been jaundiced since, and was perfectly well. Another case, operated upon two and one-half years ago, reported that he was without symptoms.

I think the important thing about the implantation of a tube is that you do not do it if there is anything else to be done. There are certain selected cases in which implantation of a rubber tube, or some other type of tube, is the only thing, practically, that can be done. Those are the cases in which a stricture of the common or hepatic ducts is too long for an end-to-end anastomosis or reconstruction. On the other hand, to make implantation of a rubber tube successful, there should remain, intact, the lower part of the common duct and the sphincter of Oddi. It is important in introducing the rubber tube for permanent residence in the common and hepatic ducts that the end of the tube does not pass into the duodenum. The tube should be larger than the sphincter of Oddi so that it will remain permanently in the ducts. If it is passed through the sphincter it will eventually pass out, and stricturing of the area in which it was implanted will again occur. It is undoubtedly true that not all of the rubber tubes will prove satisfactory. The most satisfactory, in our experience, will be those cases in which tubes can be implanted above the sphincter and the sphincter maintained.

Undoubtedly, as I stated at the recent meeting of the American Surgical Association, the best management of a stricture of the common duct is better education of surgeons, particularly in the way of better exposure of the common duct, when operations upon it are conducted.

If ever there is a place where the common duct ought to be explored it is where no one wants to do it—that is in a patient with acute cholecystitis. Acute cholecystitis always means infection of the biliary tract, and often infection of long-standing. That is the type of case in which if the common duct is not explored and postoperative jaundice occurs you would like to reexplore, but because of the infection are unable to do it. I think it is sound surgery to insist that not only should the common duct be explored in non-infected gallbladders, but, particularly, always in cases with acute gallbladders. With good exposure and careful dissection, the common duct can be as well and as safely exposed and explored in a patient with an acute gallbladder as in the subacute or noninfected or chronic type of gallbladder.

DR. HAROLD L. FOSS (Danville, Pa., closing): The patient who is subjected to a second operation upon the biliary system runs about twice the risk that he did at the first sitting. How important it is, therefore, to see to it that the first operation is properly and completely performed! Second-

ary operations are necessitated largely because the first was badly executed, or was performed on questionable indications. I am convinced that many gallbladders are removed unnecessarily.

Doctors Lahey and Clute referred to the question of postoperative stenosis; we have had six patients suffering from postoperative common duct stenosis following cholecystectomies, upon whom various plastic operations had been performed. Five of these patients were operated upon, primarily, in clinics other than our own; the first operation, in each instance, being a cholecystectomy.

DR. C. R. EDWARDS (Baltimore, Md., closing): I wish to place all the responsibility in the conduct of the case upon the surgeon. The difference between the time of operation on the appendix as compared to the time of operation in acute cholecystitis is one of hours. A patient with acute cholecystitis is dehydrated and acutely ill. He should be permitted, without sedation, to rest, but with free use of glucose and salt to bring up his body fluids. He should not receive sedation because if there is any evidence of irritation the surgeon should be permitted to detect it at once. That will require from 6 to 24 hours.

Doctor Lahey's comment about the necessity for investigating the duct is worth while, but unfortunately these patients who have been permitted to have a perforation of the gallbladder with other complications than that of peritonitis, are so desperately ill that when you remove the gallbladder or drain it, if bile appears immediately it looks as if you had opened a safety valve. Of course, if there is no appearance of bile it would seem that drainage is indicated, but if there is discharge of bile it is better just to put in a drain, because if there has been involvement of the entire peritoneal cavity, one has a desperately ill patient upon whom to perform *any* operation.

A METHOD OF HANDLING THE APPENDIX STUMP*

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THE PURPOSE of this brief communication is not to discuss the general subject of appendicitis but merely to call attention to a detail of technic.

It has long been recognized that the generally accepted method of ligation and inversion of the appendix stump leaves a portion of devitalized tissue, at least potentially infected, and pocketed-off between the ligature and the purse-string suture. That the danger of abscess formation or sepsis from this cause is more theoretic than probable, is amply attested by the thousands of perfect results following the employment of this technic.

Kross,[1] in an experimental study, found constant necrosis distal to the ligature, with ulceration of the mucosa between ligature and purse-string in many of the animals. Ochsner and Lilly[2] report two cases of abscess of the cecal wall originating from a buried appendix stump. One of these cases resulted fatally, the other recovered.

With the idea of eliminating this dead space and its contained devitalized tissue, a number of surgeons have advocated simple ligation of the stump without inversion (de Martel F. Bull,[3] C. W. Mayo,[4] and J. S. Horsley[5]). This procedure, however, is open to criticism on the following grounds: (1) Insecurity. Hilarowicz,[6] Ochsner,[2] and Edebohls[7] have reported cases in which the ligature "blew-off," with resultant peritonitis and death. (2) The formation of adhesions to the exposed stump (Torek,[8] and Willis[9]).

In an attempt to find a method which would avoid both of these disadvantages, the first suggestion was that the unligated stump be inverted, but this carried with it the obvious danger of peritoneal soiling while the procedure was being carried out.

Next, the use of the cautery to amputate the appendix was advocated by Kelly and Hurdon,[10] and more recently by Ochsner.[2] The use of the cautery has the double advantage in that it effectually sterilizes the exposed mucosa and at the same time seals off the stump, which may then be inverted without ligation. This technic would seem, then, to provide the answer to these two problems.

It so happens, however, that some of the more popular gases used for anesthesia—for instance, ethylene, nitrous-oxide, oxygen-ether and cyclopropane—are explosive and, therefore, render the use of cautery unwise, if not positively dangerous, while they are being employed As we have used ethylene with great satisfaction for a number of years, and did not wish to abandon it, the following method was devised.

* Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

Because of the simplicity of the procedure it is probable that it has been previously described, but if so, the report has not come to my attention.

FIG. 1.

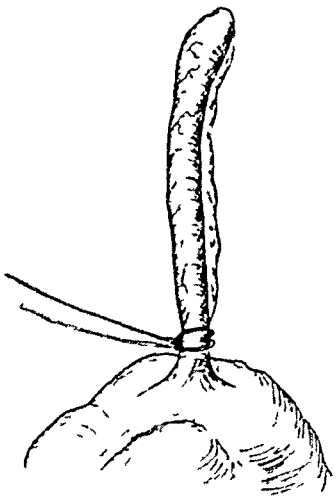
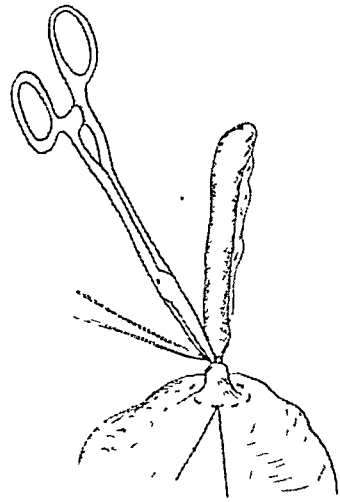


FIG. 2.



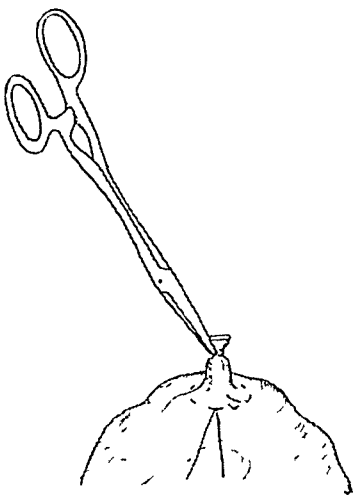


FIG. 3.

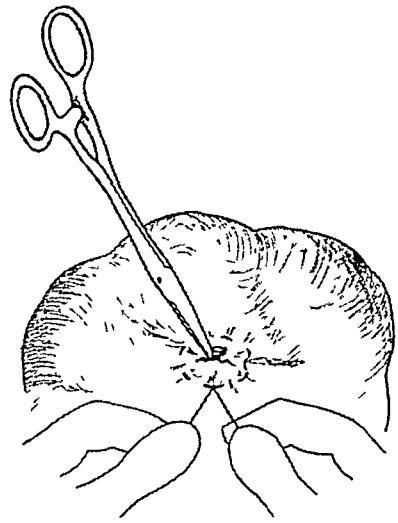


FIG. 4.

FIG. 1.—Showing application of the loop ligature

FIG. 2.—Showing the loop-ligature drawn firmly about the crushed area of the appendix, and the application of the tip of a clamp to maintain the compression; also the introduction of the purse-string suture

FIG. 3.—Showing the ablation of the appendix.

FIG. 4.—Showing the continued application of the clamp, until the stump is inverted by the purse string suture.

The technic of Lenander, as illustrated in Kelly and Hurdon's[11] "The Vermiform Appendix," shows a temporary loop of suture material being used instead of a ligature for the appendix stump, this loop being removed before the stump is inverted. Obviously, the removal of the loop permitted the possibility of leakage. The method was, therefore, modified as follows:

Technic of Inversion of the Appendix Stump.—After turning back a cuff of peritoneum, the base of the appendix is crushed with a Kocher clamp and a loop of zero plain catgut is drawn firmly around the crushed area (Fig. 1).

Both strands of the ligature are caught with a straight hemostat as near the tip of the clamp as possible (Fig. 2). Pressure on the clamp, exerted against pull on the double strand of catgut, makes the loop as snug as desired. The purse string-suture of fine black silk is then placed, particular care being taken to encircle the branch of the appendix artery which is frequently found in the wall of the stump (Ochsner[2]) (Fig. 3).



FIG. 5.—Photograph of inside of a cadaver's cecum showing the inverted appendix stump to be open.

After suitable protection with moist sponges, the appendix is clamped off just distal to the loop, amputated with a knife (Fig. 3), and the stump carbolized and neutralized with alcohol. The double strand of catgut is then cut flush with the jaws of the hemostat and the stump inverted through the purse-string suture.

Only then is the clamp released and the purse-string drawn tight (Fig. 4). A reenforcing mattress suture of fine black silk is placed, the inverted stump gently pressed between thump and forefinger to open it up, and the stump of the meso-appendix brought up and used to cover the suture line.

TABLE I

Pathologic Condition	No. of Cases
Acute	50
Acute, with gangrene	13
Acute, with gangrene and perforation	7
Interval	15
Incidental to pelvic operation	41
Total	126
Deaths	0

Firm and positive control of the appendix stump is provided by the clamp so that possible contamination of the wound edges is eliminated.

It would seem obvious that the free, short, loop would promptly release the inverted stump, but in order to demonstrate this beyond doubt, the technic

was employed on a cadaver. Figure 5 shows the appearance of the inverted stump from the inside of the cecum. It is apparent that the stump is open.

During the past 11 months this technic has been employed by the author in 126 cases; it was found applicable in each of the varieties encountered. There was no mortality in this series (Table I).

CONCLUSION

Inversion of the appendix stump by means of a loop rather than a ligature is advocated.

REFERENCES

[1] Kross: Arch. Surg., 39, 1016, 1939.
[2] Ochsner and Lilly: Surgery, 2, 532, 1937.
[3] de Martel, F.: Bull. et mém. Soc. de chir. de Paris, 46, 1438, 1920.
[4] Mayo, C. W.: Southwest Med., 18, 397, 1934.
[5] Horsley, J. S.: Operative Surgery, St. Louis, The C. V. Mosby Co., 1924.
[6] Hilarowicz: Zentralbl. f. Chir., 59, 2407, 1932.
[7] Edebohls, Geo. M.: Ann. Med. Sci., 109, 650, 1895.
[8] Torek: Quoted by Ochsner.[2]
[9] Willis, Murat: ANNALS OF SURGERY, 48, 74, 1908.
[10] Kelly and Hurdon: W. B. Saunders & Co., 1905, p. 572.
[11] *Idem; ibid.*: p. 575.

DISCUSSION.—DR. J. SHELTON HORSLEY (Richmond, Va.): There are certain biologic principles that should underlie all surgical operations, though they may not superficially appear to be mechanically admirable. One of the objections raised to the simple ligation of the stump of the appendix is that the ligature might "blow-off." Properly applied ligatures hold, and a ligature on the stump of the appendix is more easily applied and should hold better than a ligature on a blood vessel; there is less tension in the cecum than there is in an artery.

While, as a rule, it is well to approximate peritoneal surfaces, there are distinct exceptions. Polypi from the stomach or rectum are frequently removed from the lumen, and the pedicle is tied or sutured from within. Dr. B. C. Willis, in a paper read before this Association some years ago, showed that in intestinal wounds made by birdshot the patient was more likely to survive if the wounds were not sutured than if an extensive operation was performed and the wounds were sutured. The mucosa prolapses into these small wounds and closes the opening.

A ligature applied to the base of the appendix should be placed *without* first crushing the base of the appendix. In this way the mucosa has a minimum amount of trauma and merely rolls back.

Dr. H. E. Robertson, pathologist of the Mayo Clinic, has reported that in every case in which the appendix has been removed and the stump inverted, as an incidental procedure to another surgical operation, and the patient has died from the major procedure, necropsy has always shown that there is a pocket of pus within this cavity of the buried appendix stump. Usually, of course, this ruptures into the bowel—but why create a condition in which we must depend solely on Povidence? When the stump of the appendix is buried, a closed cavity is created, within which is necrotic material—the stump of the appendix; and a foreign body—the ligature; and, to make bad matters worse, the nutrition to this pocket is partly cut off by the purse-string suture!

Since January 1, 1931, to October 1, 1940, at St. Elizabeth's Hospital, we have performed 1,142 appendicectomies, in which the appendix was the sole or the main lesion. This does not include appendices removed incidentally in the course of other operations. There were, in this series, 736 cases of acute appendicitis without perforation; 95 cases with perforation and local peritonitis; and 42 cases with spreading peritonitis. There has been no death from primary appendiceal peritonitis. Two deaths occurred from peritonitis, in which the bowel had to be resected. Of the total number of 1,142 cases, there have been eight deaths or 0.7 per cent.

The technic that we employ has nothing original about it. We ligate the stump of the appendix and the meso-appendix; sever the meso-appendix, tie the ligature on the meso-appendix around the stump of the appendix; sever the appendix, perferably with the cautery; disinfect the stump with pure carbolic; and pass the ends of the ligature on the stump of the appendix through the adjacent peritoneum-covered fat. This is done with no idea of burying the stump, but merely to bring an additional peritoneal surface to assist in digesting the stump, and to protect against drainage in cases in which there is abscess.

END-RESULTS IN REPAIR OF INGUINAL HERNIA BY A FASCIA-TO-FASCIA RECTUS SHEATH CLOSURE*

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BETHLEHEM, PA.

THE CAUSES and incidence of recurrence following operations for inguinal hernia rest largely upon certain major factors: (1) The age of the patient. (2) The type of hernia—direct, indirect, sliding, or recurrent. (3) The adequacy of the tissues forming the inguinal canal to maintain repair. (4) The method and manner of operation.

The importance of the gentleness in handling tissue, careful hemostasis, sharp and clean dissection and approximation of tissues *without tension* was stressed by Halsted years ago; and experience since his day has only served to emphasize the great truth of his dicta.

The principles of the operation for inguinal hernia are those laid down independently by Bassini and Halsted in 1889. Bassini, after high ligation of the sac, transplanted the cord above the internal oblique muscle which was sutured to Poupart's ligament, and the external oblique muscle was united above the cord. Halsted's original operation was quite similar except that the cord was placed superficial to the external oblique muscle. He soon modified his procedure, leaving the cord *in situ*—suturing the cremaster also to Poupart's ligament, and overlapping the fascia of the external oblique. Both W. B. Coley and Ferguson, likewise, early advocated nontransplantation of the cord. Later variations of the operation for hernia have largely been modifications of these methods.

In 1903, it was Halsted also who suggested that not only the rectus muscle, but the rectus sheath could be used to strengthen the repair of the lower portion of the inguinal canal, and an illustration of suturing the split margin of the rectus sheath to Poupart's ligament, originally sketched by Doctor Cushing but actually drawn by Max Brodel, appears in his report.

Bloodgood also stressed the use of the rectus muscle and its sheath in the closure of certain herniae, and stated that the weakness of the conjoined tendon is a major factor in recurrence which the use of the rectus muscle or its sheath attempts to correct.

Andrews, in 1895, advocated overlapping the aponeurosis of the external oblique muscle as strengthening inguinal canal closure.

McArthur, in 1901, proposed the use of narrow strips cut from the aponeurosis of the external oblique muscle, left attached at the pubic spine as suture material for uniting the structures to be apposed.

In 1923, Seelig demonstrated that in hernial repair a fascia-to-fascia closure gave the strongest possible restoration, and, a year later, Gallie and Le-

* Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

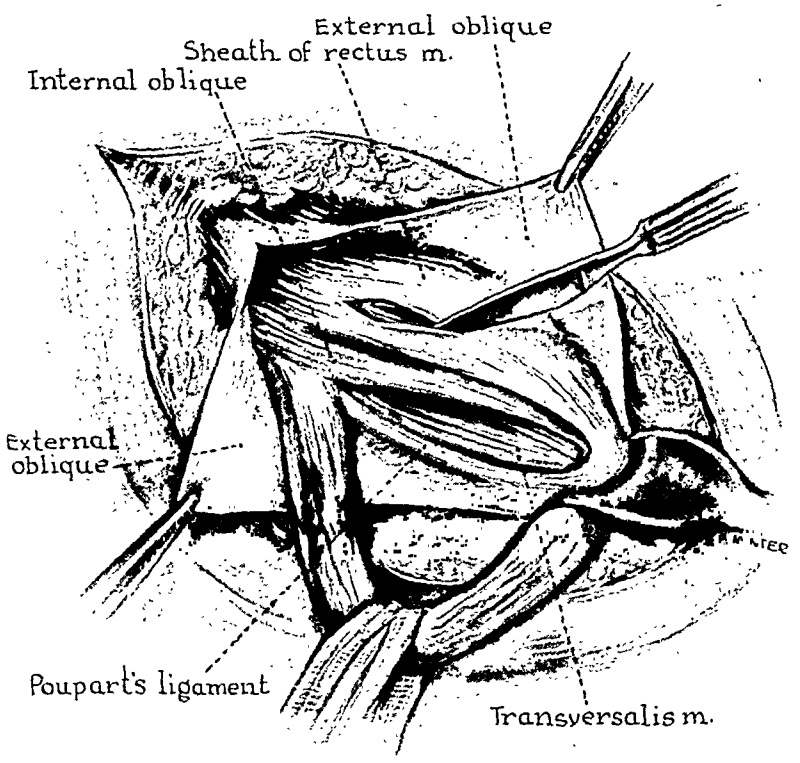


FIG. 1.—The sheath of the rectus is incised 1 cm. from the lateral margin from the level of the internal ring to the pubic spine.

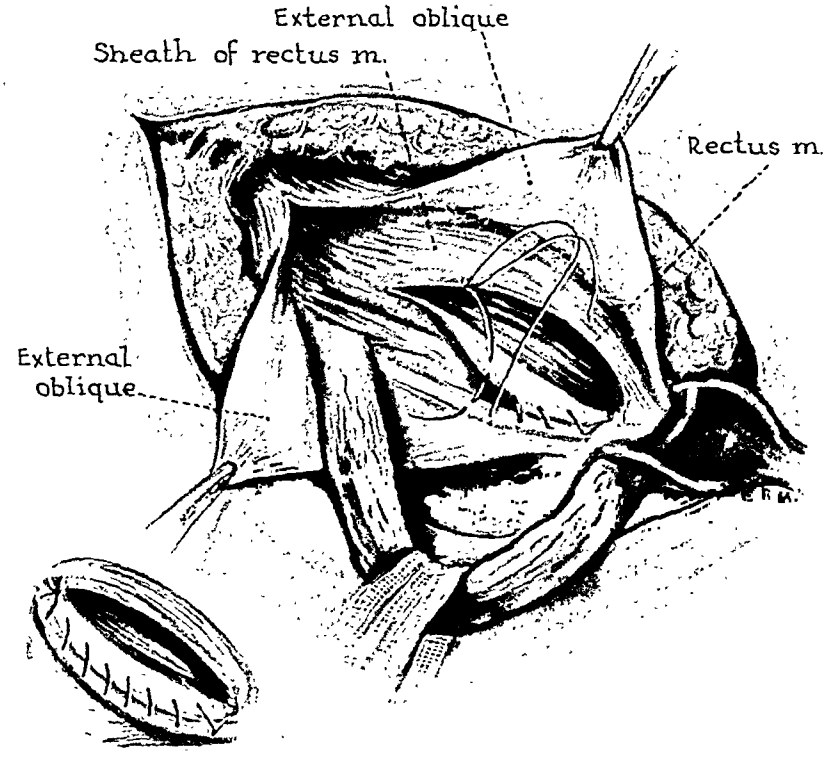


FIG. 2.—The lateral margin of the rectus sheath is sutured to Poupart's ligament.
Insert shows completed suture line.

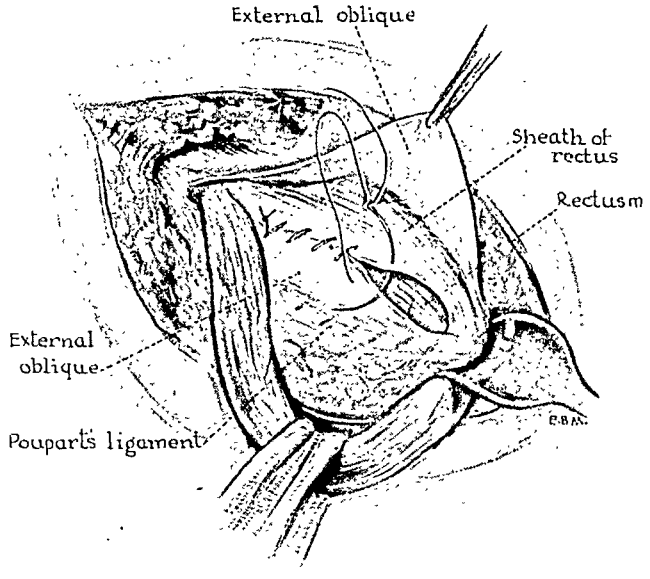


FIG. 3.—The anterior margin of the sheath of the rectus is sutured to the aponeurosis of the external oblique attached to Poupart's ligament.

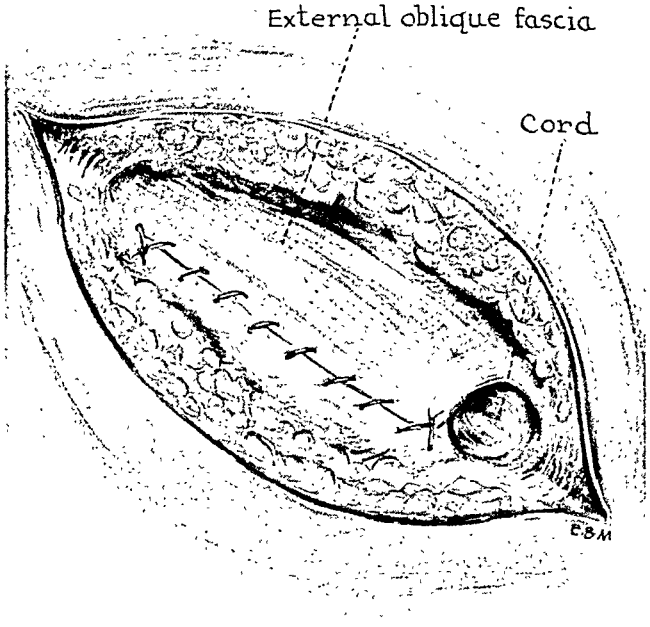


FIG. 4.—The medial portion of the aponeurosis of the external oblique is overlapped over the cord and sutured to the lateral portion of its aponeurosis close to Poupart's ligament.

Mesurier advised the use of sutures of fascia lata for the closing of difficult or large herniae.

The method of repair upon which this report is based bears largely upon the principles and procedures outlined above. It is in no sense an original operation. I first saw it employed in 1920 or 1921 by the late Dr. E. Starr Judd, but have been unable to find it illustrated in any of his published papers. Farr, and also Roberts,* has described a very similar procedure, and, apparently, Halsted and Bloodgood occasionally used almost an identical technic except that the cord was not transplanted.

Operative Technic.—An incision is made about 8 to 10 cm. long, slightly oblique to Poupart's ligament and beginning at the level of the pubic spine or tubercle. The external oblique muscle is incised over the middle of the cord—down through the external ring. The ilio-inguinal nerve is identified, freed, and retracted out of the operative field. The cord is freed, the sac isolated, incised, completely freed down to its neck, which is ligated high, and the sac then resected. If the hernia is direct, the opening in the transversalis should be closed by a purse string suture. The cremaster is separated from the cord and resected and the cord is then retracted laterally. A blood vessel is sometimes encountered beneath the cord. This should be ligated close to its juncture with the deep epigastric artery and where it crosses the pubic spine and then resected. Unrecognized crushing or trauma of this vessel in the repair may be a factor in the development of postoperative emboli. The sheath of the rectus is incised or split from the level of the internal ring to the pubic spine. This incision is made about 1 cm. from the lateral edge of the rectus muscle, and is slightly convex, curving toward the internal ring and the pubic spine (Fig. 1). The lateral *inferior* margin of the rectus sheath is then sutured to Poupart's ligament (Fig. 2). The *anterior* margin of the sheath of the rectus is sutured to the aponeurosis of the external oblique muscle attached to Poupart's ligament (Fig. 3), thus making a new floor of the inguinal canal composed of two superimposed and overlapping *layers* of *fascia*. The medial portion of the aponeurosis of the external oblique muscle is overlapped over the cord and sutured to the lateral portion of its aponeurosis close to Poupart's ligament as a new roof for the inguinal canal (Fig. 4). The superficial fascia and skin are approximated separately. Either silk or catgut may be used for suture material—tension on the suture line should be sedulously avoided.

Anesthesia.—Local or spinal anesthesia is used exclusively, as this type of anesthesia greatly facilitates the approximation of tissues without tension.

After-Care.—The patients remain in bed ten days, and a spica bandage is applied for ten days more, after which no further restraint is used. Light work is permitted after six weeks; heavy work with caution after three months. Each case, however, is individualized. No restriction of occupation has been advised solely because of the operation. Many of the males under age 50 have returned to heavy labor.

* Personal communication.

Indications.—As early follow-up examinations indicated a strong, firm closure without recurrence, for the last five years this operation has been employed as the operation of choice for all late adolescent and adult male patients. A simple Bassini operation has seemed quite adequate for children.

End-Results.—There have been 394 cases subjected to this operative procedure, of which 22 were bilateral—a total of 416 herniae; 317 indirect, 80 direct, and 19 recurrent (cases previously operated upon by other methods) (Table I). There has been no operative mortality.

TABLE I

INGUINAL HERNIAE

Total cases	394
Bilateral	22
Total herniae	416
(a) Indirect	317
(b) Direct	80
(c) Recurrent	19
	416

The patients' ages varied from 12 to 75, with 220 under 40, and 174 over 40—the greatest number being between 20 and 50.

TABLE II

AGE INCIDENCE

Age Groups	No. of Patients
Under 20	40
20 to 30	95
30 to 40	85
40 to 50	100
50 to 60	50
Over 60	24
Total	394

Follow-up Record.—Of the 394 patients, follow-up examinations were obtained in 339, or 86 per cent (Table III). Records were unobtained in 55, or 14 per cent.

TABLE III

FOLLOW-UP RECORD

	No. of Cases
Cases followed 10 to 14 years	21
" " 5 to 10 years	63
" " 1 to 5 years	74
" " 1 year or less	181
Total	339

All records are based on actual, personal reexamination of the patient except in 16 instances, in which the records of examination for employment or reemployment by large industrial firms, with competent medical staffs, were accepted. It will be noted that 181, or 53.4 per cent, were followed one year or less—all but 16 of these were observed six to 12 months after operation. It has been impossible to obtain later examinations in this group (Table III). Four of our recurrences were discovered within a year of

the operation. Shelley states that the average postoperative time for recurrence was found to be 26 months. Erdman observed most recurrences within 12 to 18 months after operation, and believed a two-year follow-up sufficient. Gibson, acknowledging the deficiency of a less than nine-months' follow-up, found that 72.9 per cent of recurrences occurred within this period.

Comment.—There was but one recurrence in the group of 271 indirect herniae, or 0.4 per cent (Table IV). This occurred within six months of the operation and was found to be a direct hernia in the lower third of the inguinal canal just above Poupart's ligament, and at a point below the level of the suture line of the superimposed medial external oblique muscle, where an opening in the fascia had probably been produced by a suture near Poupart's ligament under too great tension. A modified rectus sheath operation was employed to repair the canal. This patient has remained well and solidly healed (three years).

TABLE IV

END-RESULTS

Total Herniae..... 416
Recurrence (postoperative)..... 6 (1.4%)

Type of Hernia	Total No. of Herniae	Follow-Up Exam.	No. of Recurrences	Percentage of Recurrence (Herniae Exam.)
Indirect.....	317	271	1	0.4%
Direct.....	80	72	2	2.77%
Recurrent.....	19	17	3	17.6%

Following the usual Bassini type of operation in larger series, the rate of recurrence in indirect herniae has been reported as 8.7 per cent (Coley); 3.15 per cent (Erdman); 1.3 per cent (Gibson); and by Taylor, following the Halsted operation, 5.6 per cent. However, when the rectus muscle or rectus sheath was employed in the repair, Erdman reported 13 cases, with no recurrences.

In the direct hernia group, one of the recurrences was in a man, age 64, with bilateral herniae. The other recurrence in the direct group, and all recurrences in patients previously operated upon, were in men overweight, with a protruding abdomen (pot-belly type), in which exception intra-abdominal tension and abdominal strain can usually be suspected or anticipated. Grace and Johnson have reported a high rate of recurrence in men over age 50 (25–34 per cent).

A recurrence rate of but 2.77 per cent in direct herniae would seem gratifying, but the number of our cases is too small to speak with finality (Table IV). Following the Bassini type of operation in direct hernia, Coley has reported 16.4 per cent recurrence; Erdman 16.6 per cent; Shelley 14.8 per cent; and Gibson 6.5 per cent; Taylor, following the Halsted operation, 18.08 per cent. However, Erdman reports a small series, in which the rectus muscle was employed in the repair, to show but 11.4 per cent recurrence; Shelley found when the rectus sheath or muscle was sutured to the inguinal ligament an increase in recurrence to 25.8 per cent. Coley feels that the direct hernia

should be individualized, and that a modified Bassini operation with a rectus sheath transplant or Gallie's fascia lata sutures should be employed. Gibson advocates the use of both the rectus muscle and sheath in the closure. Fallis stresses the proper closure of the transversalis fascia and the use of fascia lata sutures for direct herniae. Joyce's recent suggestion to use pedicled strips of the aponeurosis of the external oblique muscle, as formerly advocated by McAndrew, for suture material in the repair, would, likewise, seem to have value as an optional method.

Our recurrence rate of 17.6 per cent in recurrent herniae (Table IV), though lower than some reported statistics (23.1 per cent—Erdman), indicates that the usefulness of employing the rectus sheath for recurrent hernia is limited. The use of fascia lata sutures by the method of Gallie, or McAndrew, as revived by Joyce, or McFee's transplant of cord to femoral canal, or Wangensteen's use of a pedicled-flap of fascia lata, should have particular consideration in the operative cure of this type. Wilmouth's suggestion that irritant solutions, such as 5 per cent tannic acid may be used during and after operation to increase the fibroplasia in the wound, may have merit. It is to be remembered that Burdick, and also Coley, have reported primary wound infection to be higher when fascial sutures are used. Certainly, as Coley has so well stated, the direct hernia, and particularly the recurrent hernia, should be individualized, and that method of repair employed which best suits the character and type of tissues found.

TABLE V

POSTOPERATIVE COMPLICATIONS

	No of Cases
Wound infections	3
Atrophy of testicle	12 (3.34%) (Herniae examined)
Hydrocele.	1
Total.	16

Complications.—Of the three postoperative wound infections, one occurred in a man with a postoperative delirium, who tore off his dressings, got out of bed repeatedly, and later developed a recurrent hernia. The other two infections occurred in strangulated herniae, where trauma of the intestine was present, and direct contamination of the wound from the sac resulted (Table V).

The incidence of postoperative atrophy of the testicle is high (3.34 per cent) (Table V). Erdman reports but 1.5 per cent, Joyce none. There have been no instances found during the last five years—as our early follow-up revealed its occurrence. It was found to be due either to too great enthusiasm for firm and tight closure at the internal ring of the second layer of the floor of the canal; *i.e.*, the too close suture of the medial anterior sheath of the rectus to the lateral margin of the external oblique aponeurosis, or from angulation of the cord over the sharp edge of the external oblique muscle when the suture line was carried above the normal level of the internal

ring. Closure of the internal ring, when indicated, by suture above the ring, and not carrying the line of sutures of the inguinal repair above the normal position of the internal ring has eliminated this complication.

CONCLUSIONS

A fascia-to-fascia closure for inguinal hernia, employing the rectus sheath, has proved a satisfactory procedure, with a very low incidence of recurrence in indirect and direct herniae (0.4 and 2.77 per cent, respectively). It is particularly suited to cases not previously operated upon. Care must be taken to avoid angulation of the transplanted cord at the internal ring, or atrophy of the testicle may result. For recurrent hernia, some type of operation in which fascial sutures are employed seems preferable. Certainly, in direct and recurrent herniae the case should be individualized, and that method of repair employed which best suits the type and character of tissues found.

REFERENCES

[1] Andrews: Chicago Med. Rec., 9, 67, 1895.
[2] Bassini: Arch. f. klin. Chir., 40, 429, 1890.
[3] Bloodgood: ANNALS OF SURGERY, 70, 81, 1919.
[4] Burdick, Gillespie and Higgenbothan: ANNALS OF SURGERY, 106, 333, 1937.
[5] Coley, B. L.: ANNALS OF SURGERY, 80, 242, 1924.
[6] Coley, W. B.: Am. Jour. Surg., 2, 1, 1927.
Idem: Am. Jour. Med. Sci., 109, 487, 1895.
[7] Erdman: ANNALS OF SURGERY, 77, 171, 1923.
[8] Fallis: ANNALS OF SURGERY, 106, 363, 1937.
[9] Farr: Surg., Gynec., and Obstet., 44, 261, 1927.
[10] Ferguson, A. H.: J.A.M.A., 33, 6, 1899.
[11] Gallie: Can. Med. Jour., 13, 469, 1923.
Idem: Arch. Surg., 9, 516, 1924.
[12] Gibson: ANNALS OF SURGERY, 92, 744, 1930.
[13] Grace and Johnson: ANNALS OF SURGERY, 106, 347, 1937.
[14] Halsted, W. S.: Bull. Johns Hopkins Hosp., 14, 208, 1903.
Idem: Ibid., 4, 17, 1893.
[15] Joyce: J.A.M.A., 115, 971, 1940.
[16] McArthur: J.A.M.A., 37, 1162, 1901.
Idem: Ibid., 43, 1039, 1904.
[17] McFee: ANNALS OF SURGERY, 112, 1071, 1940.
[18] Seelig: Arch. Surg., 7, 513, 1923.
[19] Shelley: Arch. Surg., 41, 747, 1940; *Ibid.*, 857.
[20] Taylor: Arch. Surg., 1, 282, 1920.
[21] Wangensteen: Surg., Gynec., and Obstet., 59, 766, 1934.
[22] Wilmouth: Surg., Gynec., and Obstet., 71, 802, 1940.

DISCUSSION.—DR. BRADLEY L. COLEY (New York, N. Y.): First, I should like to congratulate the authors of the two excellent papers on hernia, a subject of great importance. In any problem of surgery, where so many technical modifications and new procedures are advocated, it is obvious that the ideal has not yet been attained. It also indicates the failure of any one method to solve all phases of the problem.

There are many causes for recurrence after operation for inguinal hernia. Among the more important may be mentioned: Failure on the part of the

operator to identify and remove adequately a small indirect sac where the obvious finding is a direct hernia; or, overlooking the small direct or potential direct hernia while dealing with a more obvious indirect sac.

Wound infection is well-recognized as a frequent cause of recurrence, and any efforts to improve wound healing, and thus lower the infection rate, will *per se* improve the recurrence rate. At the Hospital for Ruptured and Crippled, most of us have been very much impressed by the results attendant upon the adoption, some years ago, of nonabsorbable suture material for routine hernia repair. We have satisfied ourselves that our recurrence and infection rates have been markedly lessened.

I have heard it said that the results following the use of silk are in no small measure due to the meticulous care necessary to the adoption of the *silk* technic. Some have expressed the view that if catgut were used with the same care, the results would be just as satisfactory. This view seems to me to overlook the fact that with silk there is a minimum amount of tissue reaction, and that if fine silk is used, the operator must necessarily avoid placing the sutures under tension; we believe that any hernia repair in which the sutures are under tension is apt to result in a recurrence.

I should like to emphasize Doctor Estes' statement that, in operating for hernia, one should individualize the operation, suiting it to the conditions found in each case. Hamilton Russell held that simple removal of the sac in children was sufficient. He felt that the suturing of muscle near the internal ring interfered with its normal sphincter action and was actually harmful. This sphincter action may be so affected as to prevent the contents from being extruded into a pre-existing indirect sac until some sudden strain, catching the muscles off their guard, may force the sphincter, and a protrusion results. It seems certain there is much logic in this contention.

In reporting results of hernia operations we have felt that the recurrence rate should be based upon the total number of cases followed over a period of two or more years; and it would be interesting to know whether such a follow-up of Doctor Estes' series would make any difference in his final recurrence rate. In our experience, a follow-up of less than two years is not an accurate index of the rate of recurrence.

I was much interested in Doctor Robins' operation, aiming at the reenforcement of that point in direct hernia which is notoriously the weakest, and which is the site of the majority of recurrences, *i.e.*, the space just above the crest of the pubis. His demonstration of the fact that there is a strong fascia over the bone at this point indicates that this is probably an excellent point at which to anchor sutures designed to close this defect. We have not personally employed this method, but it seems to be of definite value, and, in principle, to resemble the "high approach" operation for femoral hernia.

In closing, I should like to say a word about the applicants for employment who present themselves with a small bulge (potential direct hernia). Following a physical examination, these men are rejected by such organizations as the police and fire departments, postal service, public utilities and other industrial concerns. It has been our contention that these cases often do not warrant an operation. Now that the country is entering upon a program of national defense, with large numbers of young men being called up for examination for military service, I think it would be well to recall what Dr. William A. Downes concluded as a result of his experience in the last war, namely, that many *unnecessary* operations for "direct bulges" or "direct weaknesses" were performed in order to get the men in condition for military service, and that the percentage of recurrences following these operations was

high. I would plead for the exercise of judgment in the selection of these cases for operation.

DR. HAROLD L. FOSS (Danville, Pa.): I believe that the constantly varied methods so frequently referred to in the literature, and in the many newly devised operations perennially described, indicate that the recurrence rate is too high. There is one fundamental principle in the treatment of inguinal hernia. To succeed in achieving a permanent cure we must obliterate the inguinal canal, and that means bringing some structure down and approximating it to Poupart's ligament in such a manner that it will remain there permanently. Many years ago, Kontz, of Johns Hopkins, showed in experimental animals that muscle and muscle will firmly unite, as fascia unites to fascia, but that in the former case it takes longer. Catgut does not keep these unlike tissues in approximation for a sufficiently long period, so silk has been used by us for 20 years. Recently we have changed to cotton.

About ten years ago I reported 800 operations for inguinal and femoral hernia among the coal miners of central Pennsylvania. Many of the patients operated upon for inguinal hernia on my service are also iron puddlers, and railroad men. In iron puddlers the greatest possible strain is thrown upon the abdominal muscles. These patients must be cured and must remain so. Therefore, we tried various technics over a period of many years. Our recurrences in this period have averaged 1.8 per cent. A slight modification of the original Bassini operation, using cotton, interrupted sutures, with skin clips in the skin, the operation performed under spinal anesthesia is, in my hands, the most satisfactory procedure I have found after experimenting with every known technique in the performance, now, of some 2,000 herniorrhaphies.

Doctors Estes and Robins have cast further light on the cause of recurrences and both have suggested original and ingenious methods for improving our results.

However, as to the use of fascia; I do not know of a better example in surgery where a simple procedure has been made unnecessarily hard than the one of the repair of simple inguinal by means of fascia, and yet in the hands of many (Payne, Joyce, Estes, Gallie, Robins, *et al.*) it has been, indeed, a thoroughly satisfactory technic. In large diaphragmatic repair of the average inguinal hernia, I doubt if it is ever absolutely necessary. I am one of those stubborn individuals who believes he can cure any inguinal hernia with silk or cotton that anyone can cure with fascia.

DR. WILLARD BARTLETT (St. Louis, Mo.): Just a word with regard to atrophy of the testicles, of which we hear very little, particularly with reference to bilateral herniae of any type. I had one patient with a double postoperative atrophy. That is so serious that if anyone encounters it he will probably take steps to eliminate it. So it seems that one is justified in undertaking but one operation at a time in a patient who has need for a double herniotomy.

About recurrent herniae; we heard a lot about treatment of the abdominal wall. I think most of us are prone to forget, particularly in recurring hernia, that there are two underlying causes of which suture failure is one, while internal tension is the other. If the control of function of body orifices is interfered with, there is increased tension not only abdominal but intracorporeal. If this is given due consideration along with the type of herniotomy we just heard of, I believe there would be fewer recurrent herniae. I did the eleventh operation on a man 20 years ago. It had taken a year to get him ready, and there is still no need for a twelfth. I think this is a point that needs attention.

DR. G. B. RHODES (New York, N. Y.): I would like to describe, briefly,

an operation for repair of the rectus flap, meeting with the requirements; first, fascia-to-fascia; second, complete absence of tension; and third, ability and possibility of closing the defect of which Doctor Robins has spoken. The operation is started in the usual way as for the Bassini operation. You can place behind this the weak degenerated muscle if you wish, but I do not think it has any particular value, as the muscle is weak, relaxed, atonic, and of no structural value. A triangular flap of rectus is cut. This is brought down and out, and then passed through a slit in the fibers of the external oblique. The flap can now be sewed to the shelving edge of Poupart's ligament and as far down as the pubic spine. The rest of the operation is performed as usual.

DR. FREDERIC W. BANCROFT (New York, N. Y.): I feel that Doctor Estes has prepared for us a very satisfactory procedure in his rectus sheath closure. I have employed it as he described, but never fold in the medial portion. There is, however, one modification that might be used to advantage. It has always seemed to me that the first line of defense in the recurrent or the direct hernia is the rent in the transversalis fascia. I have been much interested in the work of Dr. Allen Fuller, of the Veterans' Hospital, in New York. As you may or may not know, the Veterans' Hospital, in New York, is the clearing hospital for all the various hospitals along the Atlantic seaboard, and it is apt to receive all the direct and recurrent herniae. Doctor Fuller believes that the bladder, when the patient is in an erect position, is one of the factors that tends to cause recurrence by hydrostatic pressure. To relieve this difficulty he dissects the bladder entirely free from the sac in direct and recurrent herniae. This leaves a raw area on the bladder, which he whip-stitches, and then passes the two ends of the suture through the rectus muscle from within outward and ties them over the rectus sheath. This procedure transplants the bladder toward the mesial line. When this procedure has been accomplished, it is very easy to isolate the transversalis fascia near the outer border of the rectus muscle. This rent in the transversalis can then be sutured to Poupart's ligament. The remainder of the procedure can then be done as described by Doctor Estes. I have performed this operation several times myself and feel it is a very satisfactory method of repair in difficult herniae. I have never seen, nor has Doctor Fuller, any disturbance in bladder function following this procedure.

DR. HAROLD FOSS (Danville, Pa.): I would like to call attention to the work of Doctors Mead and Ochsner on the use of cotton as a suture and ligature material; work which I feel may prove an important milestone in the progress of surgery. After reading their interesting paper in the April, 1940, issue of Surgery, I began, rather cautiously at first, and with some misgivings, to experiment with cotton. I now find it a material well-suited to surgery, yet one that has reposed in every sewing basket for centuries, and the value of which is but little appreciated. We have used Nos. 30 and 50 plain white sewing cotton practically continuously for the past three months in the following operations (Table I):

Including the primarily infected cases with those which were clean, we were obliged to remove cotton sutures in 2.4 per cent of all the cases, two being infected before operation was performed (Table II). I am sure that cotton will ultimately replace silk and I feel it will, in time, largely replace catgut. I fully believe cotton to be one of the very best suture and ligature materials available.

Cotton is also worth considering from an economic standpoint, this being a phase of the matter which may well intrigue our hospital superintendents. We used in our institution, in 1939, about $1,500 worth of suture material,

silk and catgut. On the same footage-basis, had cotton been used, $4.20 would have supplied us with all our suture material for a year. One cent will buy 100 feet of cotton, but will buy but three inches of catgut; a mile of catgut costs $224, and a mile of cotton 53 cents. Cotton increases in strength on boiling by about 10 per cent, and loses less than 25 per cent of its tensile strength after four weeks in the tissues, in contrast to the well-known and rapid loss of tensile strength of catgut—falling rapidly after the first 72 to 96 hours.

TABLE I

INSTANCES IN WHICH PLAIN WHITE SEWING COTTON HAS BEEN EMPLOYED

September 1, to November 30, 1940

	No. of Cases
Operations upon gallbladder and bile ducts	41
Hysterectomy and other pelvic operations	53
Herniorrhaphy	24
Thyroidectomy	25
Mastectomy	8
Appendicectomy	28
Operations upon stomach and duodenum	6
Nephrectomy	4
Operations upon colon	9
Miscellaneous	33
Dispensary: Lacerations and minor operations	35
Total	266

TABLE II

INSTANCES IN WHICH COTTON SUTURES WERE LATER REMOVED

	No. of Cases
Cholecystectomy	1
Appendicectomy (one case*)	2
Hysterectomy	1*
Bilateral saphenous ligations	3
Total	7 (2.4%)

* Previously infected.

In our hands, wound healing has been better than we have ever obtained with other materials, and tissue reactions markedly less. The perfect utility of this ubiquitous, cheap, and lowly thread, in practically all types of major surgery, has proved one of the most amazing things in my surgical experience.

DR. DONALD GUTHRIE (Sayre, Pa.): I agree with everything Doctor Foss has said about the advantages of cotton thread for ligatures and sutures.

Doctors Ochsner and Gage have made a valuable contribution in suggesting the use of cotton thread to replace silk. We have used fine silk extensively in our clinic for over five years, as we have been certain that it has many advantages over catgut, but after our experience with cotton thread for the past eight months, we believe it to be much more satisfactory in every way than silk.

DR. W. L. ESTES, JR. (Bethlehem, Pa., closing): There are two or three points I would like to touch upon briefly. It seems to me to be a perfectly just criticism that a considerable portion of our series of cases failed to have a sufficiently long follow-up to speak with finality about the operation described. Our feeling is, therefore, that this is a preliminary rather than a final report of end-results. Secondly, I believe there would be general agreement that fascia will unite with muscle, but the point to be emphasized is that a fascia-to-fascia union is stronger. Finally, there is often found, in instances of indirect herniae, a weakness or bulging—a partial or complete breaking down

of the transversalis and the posterior wall of the inguinal canal; *i.e.,* a direct as well as indirect hernia. When this anatomic set-up is encountered we have found it expedient to suture the conjoined tendon and the margin of the internal oblique to Poupart's ligament as a preliminary step before proceeding with the fascia-to-fascia closure.

DR. CHARLES R. ROBINS (Richmond, Va., closing): I did not expect to make many conversions. When a man has spent somewhere about a generation developing a technic, he is not going to jump off to something else because a youngster comes along and makes a suggestion. However, I do believe there is some virtue in what has been suggested.

Doctor Estes has referred to eminent surgeons of the past, for development of his technic and for the modifications he has made. It was those same Masters that started me to try to find something else to cure hernia. The flap from the rectus sheath was employed by Halsted and Bloodgood, and also by Downes, and all discarded it. It did not work the way they manipulated it. Doctor Downes, in a paper presented by him before this Association, said he had given up operations upon direct hernia except in certain cases. Bloodgood made the statement that where a finger could be introduced, and particularly if two fingers could be introduced and swept around behind Poupart's ligament and the rectus muscle, he had never seen a case of this sort that was cured.

Two cases came to me with direct hernia, and, at that time, having heard such very discouraging reports from the gentlemen mentioned, I told one of the patients—"You have a form of hernia which is difficult to curt and may recur, but if you want me to operate I will." So I operated upon him. At that time Babcock, who was the first one to describe the thickened ligamentous covering of the pubic bone, had an operation which he advocated and which appealed to me because he did it with one strand of catgut. So I tried it on these two cases—and one man was so impressed by my honesty in telling him it might recur, that he came back to me when the second operation was necessary. When I asked him if he wanted me to operate upon him the second time, he replied that I was honest at any rate and for that reason he had come back to me. At the second operation I employed a patch graft, which cured him, and he remained cured until his death ten years later.

I want to leave a thought with you that may bear fruit: Doctor Estes' operation represents one of the type that really accomplishes something toward the cure of hernia. The fascia is the important thing. Nobody could criticize his results. He referred to Joyce, who read a paper before the American Medical Association, in which he reported most remarkable results. I thought they were the best I had seen, but I believe Doctor Estes is getting close to it. They are using fascia. I have noted that where surgeons are making progress they are using fascia.

When we have this muscle deficiency to which I have called attention, it can be demonstrated in operations for direct hernia, if you make a golf club incision extending over the pubic bone. You will find then there is either no conjoined tendon, or merely rudimentary fibers. My opinion is, if you have a deficiency any suture you use will be under tension. Fascia is the only tissue you can apply under tension that will hold. Up to the present time I have not had a recurrence. Of course, I do not perform many. I have a private hospital, and have no connection with industry or insurance companies that would send me many cases. The only thing is, my people believe my operation will cure them, but I would like to have somebody try it on a large number of cases, without prejudice, and see how it turns out.

THE MANAGEMENT OF BILATERAL RENAL STONES*

VIEWPOINT OF THE GENERAL SURGEON

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URINARY CALCULI have been of interest for many years, whether they involved the kidney, the ureter, the bladder, or the urethra. The subject has received much study, and the stones have caused much suffering. Much thought and effort has been employed for those seeking to give relief from this condition. Some very interesting experiences have come under our observation in this field.

The amount of effort spent in the solution of this subject is evident from the numerous contributions, both by lay and medical authors from Hippocrates to the present time. Hippocrates describes in detail and with accuracy the condition, and also surgical procedures, for the removal of stones from the pyonephrotic kidney (Kelly). The perusal of these writings is interesting.

A communication by Master John Arderne (1307–1380), Cambridge Reprint (unpublished), appears in "A Mirror for Surgeons," Sir D'Arcy Power; Little, Brown and Company, Boston, 1939:

> "A stone impacted in the urethra causeth the patient to suffer right great pain and intolerable sorrow. It may be pushed back into the bladder by an instrument of silver or latten such as may be made in every good town by Craftsmen that maketh pins for women's heads or at the goldsmiths. Many a one have I so holpen. I have seen young men and old in which the stones have been so great that they could neither come out by the eye of the yard nor be pushed back but always abideth in the middle of the yard. And I cured them easily and quickly in this manner: First, I took the patient and laid him grovelling and then I bound the yard on both sides of the stone with linen bands, so that the stone might nowhere flee away, and with a little incision upon the stone with a lancet or with a razor I had out the stone, and after that I sewed the outer skin over the hole with a needle and thread, and then I laid on a dressing of white of an egg mixed with finely ground wheaten flour and left it for three days, and within fifteen days I had him perfectly cured."

Many of us have met a small stone in the urethra which was removable rather readily by simpler measures; had it been more difficult, Mr. Arderne's report would surely have been helpful.

We have noticed that the lay writers on this subject have, for the most part, considered it an ailment which causes suffering and is to be borne

* Read before the Fifty-third Annual Session of the Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

with patience. Some have seemed, however, to make rather light of the ability of medical men of the early days to relieve the condition. Michel de Montaigne,* whose autobiography, edited by Marvin Lowenthal, in 1935, we perused with much interest, says that many of his family and his friends were sufferers from stone, and those who consulted the physicians died early, while those who neglected to do so lived to about age 60. He was stricken with stone himself, and it took him quite suddenly and quite unawares. He found after a time that the condition was a good thing for him as it took his mind off some very grave and serious worries and kept it on the stone. Being a philosopher, he wrote: "What a pity I am not gifted like the man from Cicero, who, dreaming he was lying with a wench, awoke to find the stone in his sheets." He continues: "My own pains have strangely blighted my taste for wenching."

Seriously, this topic deserves the most careful consideration, and its many complications are also of particular interest. The importance of the subject was impressed upon one of us (J. G. S.) when, in 1905, during a session of the Tri-State Association of Virginia, North and South Carolina, at Greensboro, N. C., Doctor Long asked me to operate upon a physician with a tumor of very large size in the left loin. When asked for his diagnosis he said: "The deponent sayeth not." The patient had some pain during the early course of the affection, but it was never severe. He never noticed any hematuria. Rare febrile attacks were considered malaria. The mass continued to increase in size, which caused most of the patient's discomfort through the years. The diagnosis of hydronephrosis from ureteral stone was made without instruments of precision, and was based upon its slow increase in size; its location; the absence of pain on manipulation; its afebrile course, except during part of its development; and the fluctuation on bimanual palpation. Realizing no other condition which would give all these symptoms, the final clincher diagnosis was made on the table. Recovery followed removal of the kidney and the entire ureter, which was ligated at its entrance into the bladder and divided. The specimen was sent to Dr. Howard Kelly by Doctor Long, and appears in Diseases of the Kidneys, Ureters, and Bladder; Kelly and Burnam, Vol. II, 102–103, 1914.

Another very interesting case came under our care with one large stone in the right kidney pelvis and two small ones in the left. In this instance, the patient had suffered more than the one just reported and, while the condition had lasted for some time, it had forced the patient to come for relief earlier but not before the right kidney had been destroyed almost entirely by pyonephrosis. Her physician, a keen observer, recognized the gravity of her ailment and employed the means of precision before asking us to see her. There was no difficulty in making a diagnosis from the clinical symptoms and the skiagrams showed the stones clearly, while the left kidney was found present with the two small stones but performing almost the entire function (Fig. 1).

* Houghton Mifflin Publishing Company.

When such condition as the one described is met, its demand for the most accurate judgment is imperative. One cannot tell, arbitrarily, which is the better plan of treatment to pursue. In this case we had one kidney almost completely incapacitated and the other with sufficient impairment to warn us to use care in the management. Some writers upon this subject have taken the position that it is usually best to operate upon the least damaged kidney first, where both are involved with stone, and claim that

FIG. 1.

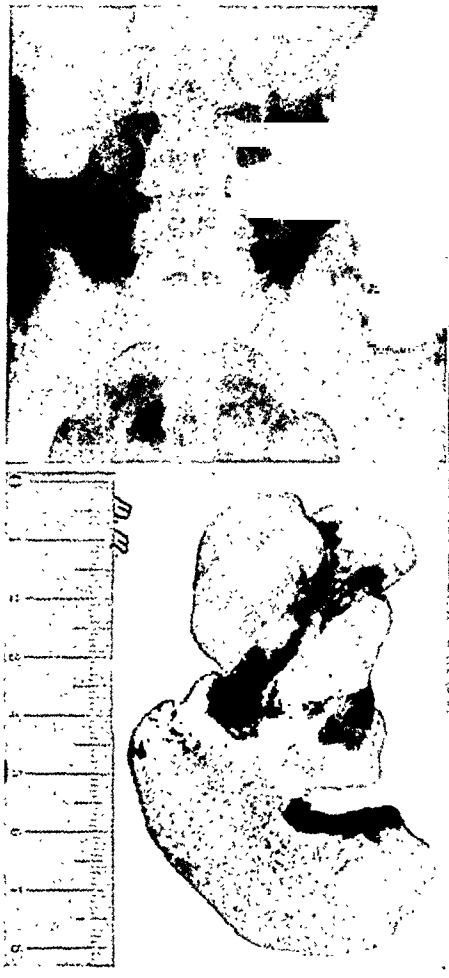


FIG. 3.

FIG. 2.



FIG. 1.—Bilateral renal stones. Right contains a very large stone. The left shows two small stones in the renal pelvis.

FIG. 2.—Pyonephrosis. Right kidney destroyed by a very large calculus.

FIG. 3.—Stone from the right kidney.

the damaged kidney will carry on to take the patient through the postoperative period and will not react as severely as will the least damaged organ.

In this case the problem was more difficult of solution because of the marked damage of the right kidney which carried the larger stone and its added infection. It was finally decided to attack the right side, even in the belief that this organ would probably have to be sacrificed. Our consultation brought this conclusion since removal of the small, and more or less "silent" stones on the left side would leave the patient without relief of her serious and painful symptoms. It also might result in failure of

the left kidney function and bring on complete anuria; therefore, it seemed that the other plan was most likely to succeed.

She was operated upon, October 7, 1922. The right kidney was exposed through a lumbar incision; a very large stone was found crowding the pelvis and impairing beyond hope the restoration of function in this kidney (Figs. 2 and 3). The immediate outcome confirmed the wisdom of the procedure. Her symptoms improved at once, and the output was 503 cc. during the first 24 hours, increasing to 562 cc. in the second 24 hours and 680 cc. on the third day. The amount arose each day until it reached 1,360 cc. on the seventh day. She was under observation for some time thereafter, and the reports were satisfactory, during which time she gained in flesh and strength, suffered no pain, no discomfort, and the urine showed no abnormal constituents.

This case emphasizes the contention so often made for early removal of stones in the renal pelvis before damage is done to the renal structures by their long-continued pressure.

This lady had not been seen for a number of years until some time ago, when we learned her present condition, which was found to be excellent. A request to be allowed to take a roentgenogram was not granted. She said: "Doctor Sherrill, those two little stones have not bothered me at all in 18 years, and I prefer not to disturb them, even to have a roentgenogram made, as I do not care to see their condition."

A very illuminating case of extremely large renal stone, with 64 minute concretions, existing through many years; destroying the left kidney; and developing both hydronephrosis and pyonephrosis, was referred by her physician, who had made the diagnosis. This was confirmed by roentgenologic and laboratory examinations, and was concurred in by us.

She was operated upon, April 13, 1940. Through a left lumbar incision, the kidney with the 64 smaller concretions, and a considerable amount of purulent urine was removed. This is a demonstration of what amount of disease can be accommodated in some cases and also shows the remarkable tissue changes in the reparative effort within the kidney tissue. It was necessary to sacrifice this kidney, but, thus, we were enabled to obtain a recovery (Figs. 4 and 5).

Many years of suffering and illness could have been avoided had she known, early in this affection, the advantage of medical advice. In the light of recent knowledge, such instances may be avoided.

In seems proper at this time to give consideration to the management of such patients who have had a successful nephrectomy. Recently, the following query was made in the Journal of the American Medical Association, 115, No. 16, October 19, 1940: "If a patient has had a nephrectomy because of massive involvement of the kidney by numerous large calcium phosphate calculi, would giving dilute hydrochloric acid, much as we do when babies have strong alkaline urines, but in much larger quantities, acidify the urine sufficiently so that a continued acid-ash diet will no longer be necessary?"

Answer (in part): "After one kidney has been removed because of extreme nephrolithiasis, calculi seldom will form subsequently in the remaining kidney." We were impressed, particularly, because it called our attention to the fact that we had no recurrence in the opposite kidney following nephrectomy.



FIG. 4.—Shows a very large calculus *in situ*.

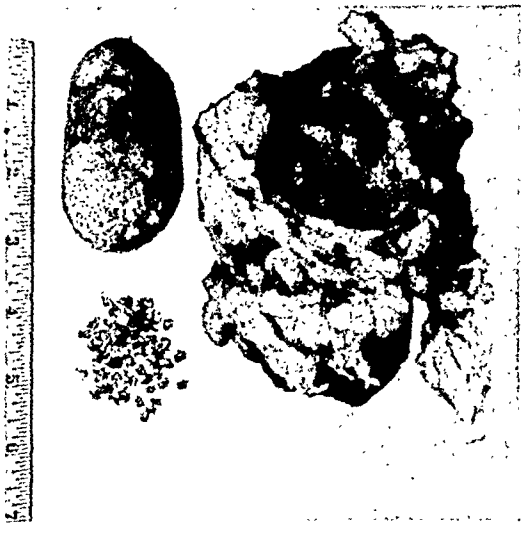


FIG. 5.—Pyonephrosis. Shows the large calculus and 64 small concretions removed from the left kidney pelvis.

Quite a number of patients have passed small stones from the kidney during the years, some with but little difficulty and others only after intra-urethral manipulation. Such cases usually go to the urologist, who is able to give the necessary time and painstaking attention and detail to this department. The presence of calculi in the urinary tract of children, according to Brenner, has been frequently overlooked, despite statistical evidence to show that urolithiasis in the child is far from an insignificant entity. The incidence, evident from these statistics, parallels, to a great extent, the economic conditions under which these patients dwell.

At present, the aids to diagnosis have improved to the point that one does not attack a case of this kind without full knowledge of the affected organ, but also with the demonstration of the presence of another kidney and its functional capacity. Since then, a number of renal, ureteral, vesical and even urethral stones have come within our purview, and they have always proven interesting. There is no department of surgery in which the refinements and the accuracy in the results of studies by methods of precision are so near perfection. This does not lessen, however, the value of the accomplishments through the years by the competent general surgeons who have relieved many such patients.

Personally, we know of no department of Surgery which has given us more satisfaction or better results to the patient. It is remarkable how long a patient will carry stones in the renal pelvis, the ureter, and even the bladder without asking for relief. It is also surprising to what size such concretions reach before coming to operation. In a number of instances we

have found the entire secreting structure of the kidney lost when the patient presents for treatment (Fig. 6).

We are impressed with the efficiency with which one kidney takes on, so successfully, the function of the organ which has been thus destroyed. The presence of calculi in both renal outlets presents additional problems to those found in unilateral lesions, which are readily appreciated. The double lesion is interesting for several reasons, because in the first place bilateral stones are not of frequent occurrence. Small stone formation in the kidney of each side is not of great frequency and the occurrence of those of large



FIG 6.—Shows a large stag horn stone

size is more rare. When the symptoms show on each side they are usually sufficient to force the patient to seek relief before extreme limits are reached, and this lessens the frequency with which large stones are found. Bilateral stones are of particular interest to the surgeon, because he is forced to decide the best method of treatment and clinical handling to conserve these structures and to bring relief to the patient promptly.

The usual complications which accompany the presence of calculus are met more often in cases affecting both sides. They deserve the very prompt consideration of the surgeon. Your attention is asked to a brief mention of those most frequently observed.

The nervous spasm excited by the irritation of a calculus, be it large or small, single or multiple, especially when formed of oxalates, phosphates, or urates with a rough exterior, is likely to cause partial or complete interruption of secretion. This may be transient or may persist to the point of danger to life. Its occurrence appears to be more likely when the kidney structure was inflamed from some form of infection prior to the deposit of crystalline salts, and results in stone formation of size sufficient to increase the presence of colloids, bacterial clumps and blood clots in the excretory ducts and renal pelvis. Thus, we find a chain of events reacting in such a manner as to form a vicious circle.

The complications following upon these events increase in proportion to the time elapsing between the first shower of crystals (particularly oxalates) and their aggregation upon the nidus of colloid or mucoid material already thrown down in the kidney pelvis. Symptoms calling the patient's attention to something unusual, which disturbs his well-being, are increased by exercise, such as walking, playing golf, tennis, baseball, etc. The more violent the exercise and the more sweating produced thereby, results in a concentration of the urine and the deposits therefrom, as well as an increase in the pain and discomfort, because of the irritation of the sharp particles penetrating into the mucosa. Rest and a change of position with sedation gives temporary relief.

The patient continues to carry on and, as it were, becomes accustomed to a minor degree of suffering and until another sudden and severe attack, which is fortunate for his well-being, because it urges him to seek medical aid.

In a discussion of this subject one must give some thought to the causes of stone formation in the urinary tract. It is well to consider the knowledge gained from the more recent investigations into the frequency and the causative factors in the precipitation of concretions from the urine. It has long been recognized that obstruction with stasis, infection, concentration and a high degree of acidity were important in the production of concretions, particularly, if a foreign body were present. The latter may be of inorganic or of organic origin.

Recent observers conclude that renal stones may, in part, be a deficiency disease. Brenner,* under incidence, states: "The presence of calculi in the urinary tract of children has been frequently overlooked despite statistical evidences to show that urolithiasis in the child is far from an insignificant entity." Gross says: "That most urinary calculi originate in the kidneys, from which they descend into the bladder where they gradually increase in size and ultimately produce obstruction." This statement is generally borne out by other observers.

Owing to the ease with which small fragments of concretions escape from the kidney pelvis, but few stones are found at present in the renal pelvis in children. Formerly, the number reported present, in large groups of cases, was quite large. Notably, in 1900, Assendelft, in 630 cases of vesical calculi

* Brenner, Edward C.: Pediatric Surgery. Lea & Febiger, Philadelphia, 1938.

in several Russian hospitals, found 77 per cent in children under 10 years of age, and 86.5 per cent in children under 20 years of age. Monte (1881) quotes Civiali, who found, that 45 per cent of 5,000 cases of calculus occurred in children, at that time. More recently, in America, in children with a higher standard of living and a better balanced diet, the incidence is much lower, yet quite significant. Notably, Hager and Magath (1928) found 15 of 1,808 renal; seven of 813 ureteral; and 11 of 674 vesical calculi in children. In 1924, Bugbee and Wollstein, in over 4,000 pediatric postmortem examinations, found 13 with renal calculi, all associated with infections. One case occurred in an eleven-day-old baby. Theodorescu (1928) reported 50 cases of renal calculi in 140 autopsies, the majority under six months of age. He concluded that faulty feeding, starvation, and attendant debility were important factors.

The patient must be advised to live in a manner which will lessen any deviation from the normal. In one of the cases described, the measures to obtain this result would not be recommended very highly. Her attendant gave her the usual instruction and advice as to diet, exercise and mode of life, with orders to drink large quantities of pure water free from a large proportion of alkaline ingredients, to partake freely of nonalcoholic drinks, and get plenty of rest after moderate exercise. As a fact, however, like most patients she was not impressed with any certain times to report for observation. It is likely that as she failed to remain long under his care, she did not long follow the rules given her. Nevertheless she has continued in good health for over 17 years, and has, to all outward signs, remained well. One cannot criticize her for remaining without a physician. Could we have given her a better chance or more certain security from the formation of another stone?

The progress in the study of the best diet for certain conditions has gone on apace with the progress in other lines and, although we have no records to back the statement, it seems likely that stone formation in the urinary tract is probably less frequent than in the past. A recent Manual of Urology* devotes only 15 lines to the subject of diet, but we confess he covers the question most succinctly. Here, the statement is made that ketogenic diet has been supplanted almost altogether by the use of mandelic acid. "This is much simpler to use, obtains results more quickly, and is more efficacious." After the removal of a stone or one has been passed he says: "High vitamin-ash diets are recommended by Higgins. In alkaline urine a high vitamin A acid-ash is prescribed, but if acid, a high vitamin A alkaline-ash diet is advised." In the effort to prevent the recurrence of the gravel, elimination of infection from the urinary tract is essential. In children when symptoms of pyelitis present, which is by no means infrequent, attention must be given to check and control it, if possible, as a preventive measure against stone formation.

Tuberculosis, in our experience, is rarely followed by stone, and, at

* LeComte, R. M.: Manual of Urology. Williams & Wilkins Co., Baltimore, 1939.

most, some shadows may be seen when calcification of its products occurs. No such case is recalled in our work. The free ingestion of water, bland, and with little lime and other basic salts should be urged. Anything which obstructs the outlet should be corrected as a measure of prevention.



FIG. 7.—Shows the head of a pedunculated stone in a diverticulum. Two smaller stones rolled around its concave surface.

The Yearbook of Urology gives much interesting information on urography, and the comparative value of intravenous pyelography is much simpler and less painful and trying to the patient, with much less damage and trauma to the bladder and ureter.

Brief mention must be made of perirenal infections resulting from perforation into this space of the stone itself, or from the invasion of the fatty tissue by contiguity of structure. This type of complication was well covered in the literature many years ago. Most of you have handled stones in the ureter and those in the bladder, and are perhaps most familiar with these conditions. We have seen some very large and interesting stones in the bladder and prostate. Also stones have formed in the pockets of diverticula. An interesting case of such stone is shown in Figure 7, where the head of a pedunculated concretion held in the pocket had a base with a concave surface upward on which a large stone with a smaller one rolled about within the bladder, adding nothing to the patient's comfort.

DISCUSSION.—DR. THOMAS S. CULLEN (Baltimore, Md.): I have thoroughly enjoyed Doctor Sherrill's excellent paper. The management of bilateral renal stones has always interested me to some extent, but ever since I had bilateral stones myself, this subject has meant much more to me.

In August, 1936, Dr. Benjamin O. McCleary, one of the squarest men I have ever known, who for years had charge of the technical work in the Gynecologic-Pathologic Laboratory at John Hopkins Hospital, came up to see the quintuplets and then visited me. We had a glorious time, but two weeks later he had a cardiac attack and was gone. I came down from camp a

week earlier than usual to attend his funeral and spent the succeeding week at Mrs. Cullen's cozy country home, Morling's Chance, near Easton, Md.

The day before I was to return to work I went out among the pine trees where the men were making a path. In leaning over to pick up a file, something happened. I returned slowly to the house, went to bed and was actively nauseated all day and all night, and had much pain in the right upper abdomen. I had had acute intestinal obstruction for five days a number of years ago, as fully described by Dr. Ernest H. Gaither in the Journal of the American Medical Association, July, 1924, and Mrs. Cullen decided to bring me up to Baltimore, on the first ferry, early next morning.

The day was beautiful, and as I lay on pillows in the back of our car in the bow of the boat, looking as pale as a sheet, I picked up the Baltimore *Sun* and at once read a most disquieting Associated Press dispatch. At the opening of the Banting Institute in Toronto in September, 1930, the University of Toronto bestowed four honorary degrees. Davidson Black, the anthropologist, who did such wonderful work on prehistoric man in China; Charles S. Blackwell, the President of the Board of Trustees of the Toronto General Hospital; Lord Moynihan, King George's surgeon, and I were given the honorary degree of LL.D. I knew that Black was dead; Blackwell had also passed away, and the morning paper brought the news of Lord Moynihan's death. I was the last of the four, and it seemed probable that my trouble was intestinal obstruction. I certainly did some intensive thinking and was unusually subdued.

Upon my admission to the Church Home and Infirmary, my surgeon, Dr. Howard Smith, had a roentgenologic examination made at once. The discomfort was due to a stone passing down the right ureter. There was also at least one stone in the left kidney. I was given appropriate treatment and also numerous enemata. I soon developed two large strangulated hemorrhoids, which it was thought might become gangrenous.

I was given novocain and pantopon at 6:30 A.M., and the hemorrhoids were removed by Dr. Gerald Ackerman at 7 A.M. At 8 A.M. I had my breakfast, and by 10:30 was as drunk as a lord. Dr. Thomas B. Futcher was called, as some thought I was having a cerebral accident. Dean Lewis and John Finney came down to see me drunk for the first time. The next morning I was all right.

The stone in the right ureter was in no hurry to move.

In 1903, I had operated at the home of Dr. Sam Trippe, of Royal Oak, upon his nephew, Joe Chamberlain, for ruptured appendix and peritonitis. The boy did well, but three weeks later developed intestinal obstruction. He was brought about eight miles on a jerk-water railroad, then about 50 miles on the steamer, and then by ambulance from the boat over a cobblestone road to the Church Home and Infirmary, which was two miles distant. The jolting had straightened out the bowel, he had a good movement, and operation was unnecessary.

Remembering this case, I had the hospital ring up Mayor Howard W. Jackson to see whether there were any cobblestone streets remaining near the hospital. There were a couple of them. Accordingly, I rode up and down one of these streets several times hoping that the jolting would facilitate the passage of the stone. In a short time I was relieved of my discomfort and soon returned home.

During my illness I had for some reason broken off two front teeth; accordingly, I really had three sets of twins—two broken front teeth, two strangulated hemorrhoids, and at least one stone in each kidney.

The value of riding over cobblestones to jolt stones down is really only

of historic interest. In most places cobblestone streets have given way to paved ones, and corduroy roads are too far removed from hospitals to be of value to weakened patients. Fortunately, my renal stones were small, and the ride relieved me of discomfort, but the stones did not pass for several weeks.

DR. HENRY D. FURNISS (New York City): I think we should thank Doctor Grant for his method of demonstrating these cases in which he has done air pyelograms. He exercised very good and proper precautions. It has great value in cases in which it is desirable to take a picture of the kidney with the patient in the erect position. He spoke of the use of air; I think carbon dioxide is safer. If you should have any kind of accident, carbon dioxide is absorbed very quickly. It is easy to use, and it can be obtained at the drug store without trouble. Dry ice is dropped in a beaker of water, and the gas that accumulates is removed with a syringe.

This method has some value but I do not think it will ever displace the contrast media. Carbon dioxide is quickly absorbed from any contact with water. In the Rubin test, if the apparatus is clamped off with the gas under pressure, there will be sufficient absorption to produce negative pressure in three or four hours.

With reference to Dr. Sherrill's paper, he has given us some excellent work. One thing he brought out is the influence of drainage. We have dilated the obstructed ureter after operation, and when infection is present, lavaging the pelvis with 0.5 per cent silver nitrate. After such treatment recurrences have been definitely less frequent.

DR. IRVIN ABELL (Louisville, Ky.): This is an extremely interesting paper on a surgical condition that offers many problems for solution. So far, the studies that have been made do not completely explain the origin of all renal calculi. A number of important, and seemingly independent factors may be responsible for disturbing the colloid-crystalloid equilibrium of the urine and initiating the mechanism of stone formation. Among these may be mentioned stasis, infection, vitamin deficiency, metabolic perversions, trauma, papillary or caliceal ulcerations, and disturbance in calcium-phosphorus metabolism. Our present knowledge does not adequately explain the formation of a pure uric acid calculus in one person, a pure oxalate calculus in another, and a triple phosphate calculus in yet another. It does not clarify the difference between the person who forms and passes but one stone and the individual who repeats and repeats. It does not elucidate the problem of the patients who, for long periods of time, eliminate phosphates, oxalates and urates in the urine without the formation of stone.

Again, the kidneys are bilateral organs, and primary stones are unilateral in approximately 75 per cent of all cases, leaving 25 per cent in which they are bilateral. In our observation, the latter may be roughly divided into two groups: One in which the stones in each kidney are of equal size; and one in which a large stone occupies one kidney, with a smaller stone in the kidney or ureter of the opposite side. When large-branched or stag-horn calculi occupy both kidneys, and the latter give no evidence of active infection, it becomes a moot question as to whether or not such patients will live longer and more comfortably without operation than with it. The inevitable injury to renal tissue in the removal of such stones, and the almost invariable recurrence, have led many to employ operative treatment only in the presence of complications. The supervention of infection, if limited to one kidney, is an indication for operation on that side; if it involves both

kidneys, the extent of renal impairment will determine for or against the advisability of operation.

When the stones are of smaller size and occupy positions accessible to removal through pyelotomy incisions, the only contraindication to operation is the presence of such renal damage as to make the prospect of regeneration a hopeless one. In the second group, characterized by a large stone in one kidney and a smaller one on the opposite side, granting the function of the side containing the smaller stone is satisfactory, the latter should be removed. The disposition of the kidney with the large calculus will depend upon function, impairment of renal tissue, quiescence and infection; if pyonephrotic, its removal will be indicated both to prevent recurrence in it and as a protection to the opposite side. It is axiomatic in the operative removal of calculi from both sides of the urinary tract, to operate upon but one side at a time, and it has been quite generally the custom to operate first on the side showing the best function, in order to conserve this property as far as possible before approaching the more badly damaged one. We have made exceptions to this rule in pyonephrosis, giving rise to fever and constitutional disturbance, and in the cases in which the calculus on one side was situated in the ureter or at the ureteropelvic junction, the active pyonephrosis demands immediate attention regardless of the better function on the opposite side, and the ureteral and ureteropelvic stones, because of their greater opportunities for causing acute obstruction and infection, had best be removed first as a precautionary measure. Again, if one kidney is causing severe pain, it should be operated upon first, regardless of whether or not it is the more damaged of the two, since pain is an indication of active disease in a kidney possessing functional value, the saving of which becomes a prime consideration. It is difficult, if not impossible, to draw hard and fast rules for the management of bilateral calculi; renal function; size, number and location of stones; infection—age and general physical condition of the patient all enter into the picture and must be evaluated in reaching a decision.

Dr. Lawrence R. Wharton (Baltimore, Md.): There are two points I want to bring out. One has been emphasized by Doctor Abell, about the people who have both kidneys involved with stones. I think there are exceptions to the statement he made that persons who have large stones in both kidneys live longer if they are not operated upon. In persons who have large calculi, particularly if there is infection and poor ureteral drainage, the lease on life is very short. I know this from my own experience with patients who are living after 10 or 12 years, after having many calculi removed from both kidneys.

The second point I want to make is the necessity and advisability of conservatism in all types of renal and ureteral surgery for stone. The proponents of radical surgery have advocated that the hydronephrotic or damaged kidney will not come back and should be removed if the opposite kidney is sound. I know of cases in which ureteral stones have completely obstructed the ureter, and reduced the renal function to zero. Passage of the stone was followed by complete return of function of the kidney. That refutes the contention that the hydronephrotic kidney will not come back if the opposite kidney is normal. If the kidney is capable of regeneration, an effort should be made to save it rather than take it out.

Dr. Owsley Grant (Louisville, Ky.): I just want to say how much I enjoyed Doctor Sherrill's paper. It is always inspiring to hear from a man who has had such an extensive experience. The things he emphasized are important, and I think the two most important are that in either bilateral or

single calculi of the kidney, the stone is not a disease but a symptom. These conditions require constant treatment after they are removed. Bilateral stones present a much more complicated problem. Now as to drainage in these cases: Any case in which it is necessary to remove a stone of considerable size, it is necessary to continue this until the kidney has had an opportunity to recover. As to the question of which side to operate upon: That is a matter of dogmatic and didactic instruction. We used to be told to operate upon the bad side, and now it has come back to operating upon the good kidney—the problem depends largely on the function, and the seriousness of the condition.

I wish to thank Doctor Furniss for the suggestion as to carbon dioxide. I did not know it could be done so easily. We have had no difficulty with the air pyelogram, and have found it helps greatly in some of these complicated cases.

DR. J. GARLAND SHERRILL (Louisville, Ky., closing): When first considering this topic I did not know the extent of the undertaking; since it has led me far afield in the literature.

Doctor Grant's remarks are particularly pertinent, and I agree with what he has said. One patient, mentioned before, carried stones in the left ureter for considerably more than nine years. We did not have the instruments of precision we now have to aid in making the diagnosis, and the patient, himself a physician, did not suspect that he had any stones, but intermittent ureteral obstruction resulted in constant, gradual increase of an hydronephrosis. We must remember that a "quiet" stone may cause symptoms that resemble obstruction of the intestine and may receive treatment for that condition until the stone is discovered. Fortunately, though formed in the renal pelvis, these concretions do not usually remain there, but tend to lodge in the ureter, and there cause blocking, with resultant more or less severe pain. Why they form on one side and not on the other is not entirely clear, but it is reasonable to suppose that either spasm or organic stenosis of the ureter is an important factor. When they appear in both pelves it must be concluded that there is a bilateral congenital obstruction on each side.

The discovery by Mandl, in Vienna, in 1925, and by Dubois, in this country, in 1926, that *osteitis fibrosa cystica* is a manifestation of hyperparathyroidism, has awakened the profession to this subject, and it has been quick to apply this knowledge not only to the diagnosis of this disease but also to its treatment. As a result of these studies, it has been found that the increased excretion of calcium and phosphorus in the urine not infrequently leads to the formation of urinary calculi (23 times in 83 cases). Occasionally, the precipitation of calcium phosphate occurs in the renal parenchyma, mostly in the collecting tubules, and leads to kidney contracture and insufficiency. In one case in this series a plain roentgenogram revealed in the region of each kidney stellate groups of punctate shadows outlining the pyramids. This observation of Fuller Albright, and his coworkers gave the clue to the proper diagnosis.

Based on the predominance of skeletal or urinary tract involvement and the degree of change in each system, several different types of disease are described. They state that, whereas "the disease may produce a fatal issue—usually from renal involvement—it probably smolders on for years, in the majority of instances crippling, but not killing."

In this connection, this contribution becomes very important both in the prevention and the treatment of urolithiasis, and it opens an entirely new line of thought to the student of the causation, course, prevention and cure of

urinary concretions and their many complications. Hypercalcemia has been previously recognized as present in brain tumors and the occurrence of renal stones was considered as the result of the confinement necessary to its treatment.

Albright, Cope, Baird and Bloomberg[1] consider the subject of the physiology of the parathyroid glands. They review 83 cases of hyperthyroidism, and point out that "the presence of renal stone should suggest the possibility of hyperparathyroidism," and two cases are cited where this one finding alone led to such a diagnosis and removal of a parathyroid adenoma in each instance. They also conclude: "As regards the prophylactic therapy for the prevention of renal damage in hyperthyroidism, it is pointed out that fluids should be forced; that an alkaline urine should be avoided; that ammonium chloride and presumably other acidosis producing salts are contraindicated; that a high phosphorus diet, while indicated for the demineralization, imperils the kidneys and should be used only when the blood values can be carefully followed; and that the same applies to a high calcium diet, although to a less extent."

REFERENCE

[1] Am. Jour. Med. Sci., 187, 49, 1934.

AIR PYELOGRAPHY*

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THE EMPLOYMENT OF GAS OR AIR as a medium for outlining the pelvis of the kidney is not a new procedure in urology. There have been some difficulties following its employment, but, on reviewing the literature, each of these, apparently, was the result of the operator disregarding the fundamental principles of the method.

Pneumopyelography was introduced by von Lichtenberg and Dietlen,[7] in 1911, and met with favor for some 15 years. The English and American literature contains but an occasional reference to the method; and the series of cases reported by Hughes,[4] in 1938, is the most extensive. It is still used, but, we think, not to the extent that it should be. We do not recommend it as a routine, but feel that there is so much of diagnostic value to be gained by its employment that, if properly performed, it has an extensive field of usefulness.

The danger of air embolism has been the bugbear of the method, and it seems to us that by proper discrimination and strict technic the danger can be entirely obviated, if indeed, such danger really does exist. Air emboli have always been a disputed factor in medicine. But it is well to lean toward the side of safety, and in the procedure of pneumopyelography we feel that our technic is entirely free from any danger.

Certain gases, especially oxygen, were used in the past because it was thought to be more rapidly absorbed than air, but this means the employment of gas tanks and a manometer, and adds to the intricacy of the procedure and, to our minds, is not so reliable as the much simpler method we follow. If there be danger, Kornitzer[5, 6] pointed out in his discussion, it is due to hyperpressure in the kidney pelvis. This, of course, is equally true where liquid media was used. He maintained that since the renal capillary blood pressure was 30 Mm.Hg. (von Lichtenberg) the pressure within the renal pelvis must not exceed 30 Mm.Hg. During the short life of gas pyelography several instruments were developed so that one could observe the exact pressure created in the renal pelvis. However, it has been our experience that by using a No. 5 F ureteral catheter, and injecting air or fluid without force, that the attached manometer never reads above 25 Mm.Hg. Hence, we have used a technic essentially that described by Hughes,[4] though developed independently.

Technic of Air Pyelography.—A 10 cc. Luer syringe, fitted with an adapter which contains cotton to filter the air, is used to inject the kidney pelvis. Two facts about the catheter are important: (1) It should be of small size, pref-

* Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

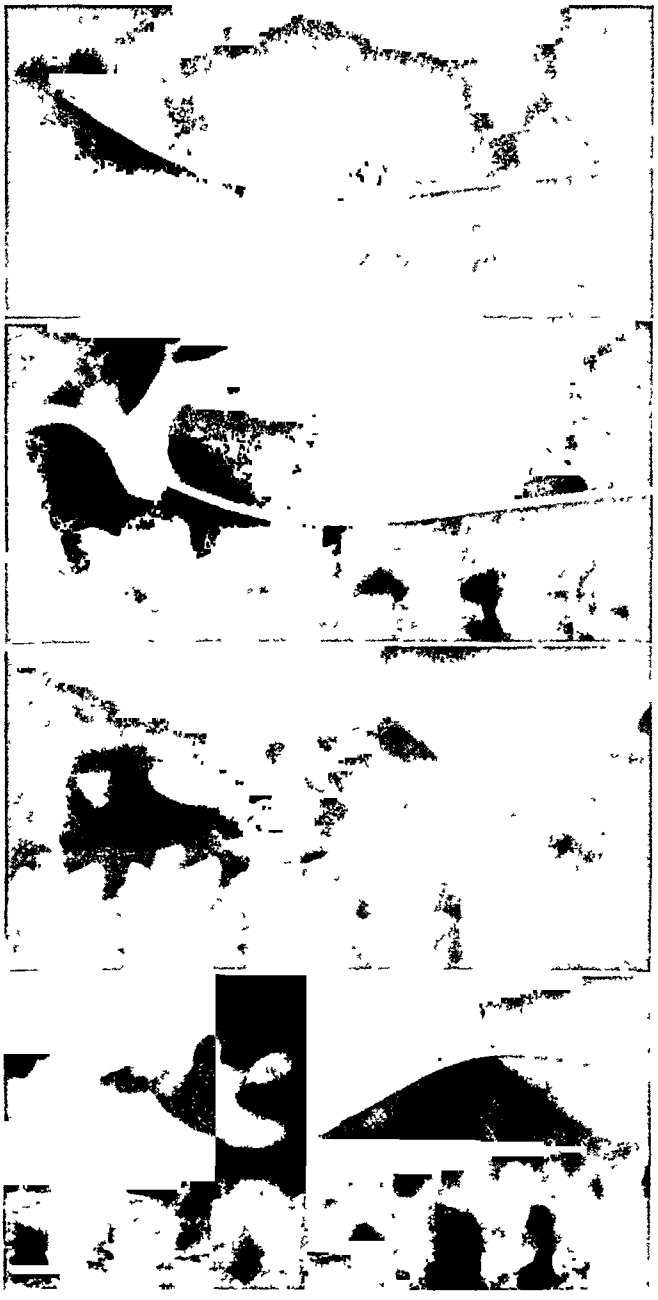


FIG. 1.—Pyelogram with Skiodan showing filling defects suggesting calculus at upper part of renal pelvis.

FIG. 2.—Same picture made with air distention of pelvis showing marked contrast between stone and media.

FIG. 3.—Pyelogram with Skiodan media showing gestive filling defect in type of lowest calix.

FIG. 4.—Same case showing air pyelogram with definite contrast between stone and media.

erably a No. 5 F, so as to permit any possible backflow of air along its side into the ureter; and (2) it must lie in the pelvis of the kidney and not in the calix. This is accomplished by introducing the catheter until it drains. The pelvis is flushed with sterile saline and the catheter withdrawn until it ceases to drain. It may be assumed, then, that the catheter lies below the ureteropelvic junction. It is then reinserted, 0.5 cm. at a time, until drainage is reestablished, and we can feel certain, then, that it lies in the renal pelvis and is not impinging on any renal tissue, and thus give any opportunity for the production of air emboli.

The air is then injected slowly and, after a little practice with a manometer, the operator can readily estimate his pressure, which should not exceed 30 Mm.Hg. The patient should be in the erect or semi-erect position, so that the air ascends readily. If 10 cc. of air can be injected without discomfort, a roentgenogram is taken. Regardless of how little air is injected, if the patient complains of pain or fulness in the back, no further air is introduced until a roentgenogram has been taken. If the same care is exercised in making air pyelograms as in the use of fluid media, we feel there is no increased hazard in its employment.

The contraindications are in all cases where a retrograde pyelogram would be inadvisable and in cases of frank, marked renal hematura.

We often employ the air and opaque media pyelogram in the same patient, in order to emphasize or detect certain points. In these cases, it is necessary to employ the air pyelogram first, because residual opaque media will, if that substance is used first, tend to confuse the diagnosis.

One definite advantage of air pyelography is its rapid absorption. We have followed this through a series of normal and abnormal kidneys, and find the average time for complete disappearance to be between three and seven minutes. This obviates the leaving of a heavy media in the pelvis in certain cases, which often causes severe postcystoscopic pain in an obstructed pelvis.

Indications.—We do not employ air as a routine, because, we believe, it does not give as distinct a picture of the calices as does opaque media injected in the Trendelenburg posture. But we have found it of inestimable value in accurately and positively locating the position of small stones or fragments of large stones, so necessary to be removed and so easily overlooked. In the presence of stones, the opaque media covers them entirely and their exact location is often a matter of guesswork. In air pyelography the contrast between the opaque stone and the nonopaque air presents a distinction that is most striking and will locate even a small fragment most precisely.

Air pyelography finds its greatest use in calculous disease of the kidney; and we feel accomplishes a purpose there unobtainable by any other method.

When used with care, we believe it is no more hazardous in those cases where it is indicated than the halogen pyelogram.

It is, unquestionably, less irritating to the patient and causes less postoperative reaction.

The air may be left in an obstructed pelvis to diagnose an occlusion or aberrant renal vessel or kink with impunity; and with the knowledge that it will be quickly absorbed.

In our experience we have never had the slightest untoward effect, and are impressed by the satisfaction it affords both the urologist and the patient.

REFERENCES

[1] Bruger and Fuchs: Quoted by Kornitzer.[6]

[2] Gilles, C. L., and Kerr, H. P.: Roentgen Diagnosis of Lesions of the Upper Urinary Tract. Radiology, 28, 565–575, May, 1937.

[3] Granger: Oxygen in Cystography and Pyelography. Am. Jour. Roentgenol., 3, 351–354, July, 1916.

[4] Hughes, B.: Diagnostic Value of Air Pyelography. Penn. Med. Jour., 41, 897–899. July, 1938.

[5] Kornitzer, E.: Pneumopyelography. Wien. klin. Wchnschr., 39, 1157–1159, September 30, 1926.

[6] Kornitzer, E.: Defense of Pneumopyelography. Wien. klin. Wchnschr., 40, 1203–1205, September, 1927.

[7] von Lichtenberg, A., and Dietlen, H.: The Demonstration of the Kidney and Ureter with X-ray Following the Introduction of Oxygen. Munchen. med. Wchnschr., 58, 341–344, 1911.

THE SURGICAL TREATMENT OF ARTHRITIS*

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ARTHRITIS, monarticular and polyarticular, constitutes one of the most important medical problems of our day. This is so because arthritis has not only a medical aspect, entailing pain and suffering, but also has an economic aspect which arises from the frequency with which it causes partial or complete incapacity, the result of the serious joint disturbances and deformities which it creates. Such deformities are more serious so far as the patient is concerned than any other feature of the disease, since they persist and frequently grow worse after the arthritis has become quiescent. While, during the past two or three decades, intensive study has cleared up many obscure features of the disease, little attention has been directed toward the prevention of the deformity, and the condition of the patient in the advanced stages of chronic arthritis is, in consequence, pitiable. With major joints fixed in faulty position, hands deformed and useless, feet swollen and distorted, muscles wasted, and confined to bed or wheel chair, they present a picture of complete invalidism. Such a situation could not help but be a challenge to modern surgery, and surgery has responded to this challenge by devising a number of procedures for the relief of the arthritic cripple. Some of these procedures have failed to justify themselves and have been discarded or modified, but a number have withstood the test of time and are of great service in relieving pain, bringing about, to a most satisfactory extent, improvement in joint function and restoring to useful activity severely incapacitated individuals. It is proposed here to briefly discuss those surgical procedures which have been found to be most worth while in rehabilitating the arthritic cripple.

Before proceeding with a discussion of the specific surgical operations available for the relief of the arthritic cripple, it is necessary to state the indications which call for surgical intervention, and to set up criteria which will aid in determining when such surgical intervention should be initiated, and what form it should take.

There are two indications for surgical intervention in the arthritic patient: (1) Incapacitating disability; and (2) the necessity for removing a focus of infection which is active in propagating the disease.

As to the first of these indications: In the arthritic patient a number of joints may be impaired in function and cause comparatively little incapacity; while, on the other hand, impairment of one or two important joints may result in a high degree of disability. In the upper extremity, loss of the shoulder, elbow, and wrist joints may place the individual in the same situa-

*Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

tion as the armless, so far as eating and the acts of toilet and personal care are concerned. In the lower extremity, loss of function in the hip, knee, and ankle joints interferes with locomotion and the ability to get up and sit down without assistance; when both extremities are affected, the individual must lead a bed or wheel chair existence. Under such conditions, even if economic independence cannot be restored, the social betterment to be anticipated may justify the attempt to make life more livable and satisfactory.

The removal of foci of infection through surgery on one or more joints has a very definite place in the treatment of arthritis, in the opinion of many. In certain types of polyarthritis, particularly the so-called villus form, characterized by boggy, swollen joints, showing some degree of activity, the actively inflamed synovial membrane is definitely under suspicion as a focus of infection, which rivals the teeth and the tonsils as a source for the propagation of the disease. It has been our experience that the removal of such diseased synovial membrane results in improvement in the systemic disease in a very considerable proportion of cases. For example, in 27 cases of polyarthritis in which the operation of synovectomy was performed upon one or more joints, 22 cases showed marked and continued improvement in other joints previously painful and impaired in function.

Two factors are important in appraising the situation in the arthritic patient as to the most favorable time for operation and the type of operation to be employed when surgery comes into consideration. These two factors are: (1) The nature of the joint involvement; and (2) the extent of the joint damage present.

The nature of the joint involvement has a very important bearing on the time of surgical intervention. Chronic arthritis to-day is subdivided into two main types: (1) Atrophic or rheumatoid arthritis; and (2) hypertrophic or osteo-arthritis. The former is characterized by multiple joint involvement and a subacute course, with frequent exacerbations of acute joint inflammation; its pathology consists in destructive proliferative joint changes which eventually lead to partial or complete ankylosis. Osteo-arthritis is characterized by slowly developing degenerative joint changes, which may affect a few or many joints; its course is never acute, and it practically never leads to bony ankylosis. In the atrophic type of arthritis, surgery should not be undertaken until all acute symptoms have subsided, and the joint has become reasonably quiescent. In the hypertrophic type, there is, strictly speaking, never any acute stage, and surgery may be undertaken at any time.

The extent of joint damage determines largely the type of operation which is performed. The joint structures which are involved in any arthritic process are the ligaments, the synovia, the articular cartilage, and secondarily, the muscles which control the joint. When joint deformity and impairment are due solely or largely to thickening and contracture of the ligaments and muscles, one type of surgery is indicated, for example, manipulation or capsuloplasty. With thickening and active infection of the synovia and serious damage to the articular cartilage, the operation of synovectomy may be em-

ployed. If there is complete disintegration or ankylosis of a joint, arthrodesis or arthoplasty must be resorted to.

Surgery, then, may play a successful rôle in the relief of the arthritic patient when the arthritis is in the quiescent stage, the pathology present has been properly evaluated, and loss of function in important joints has resulted in incapacitating disability. When these criteria are met, it is frequently possible in properly selected cases by a carefully planned surgical attack on one or more joints to convert a helpless invalid into a reasonably active individual, who can take care of himself and at times become self-supporting. In planning such a reconstruction campaign, it should be recognized that surgery in arthritic cases has three objectives: (1) Relief of pain; (2) the correction of the deformity; and (3) the restoration of function. Frequently, the first two of these objectives are one; more often than is realized, pain in the arthritic joint or joints is not caused by active disease, but is the result of strain on damaged or deformed joints with associated muscle spasm. Such pain can be relieved only by correcting deformity. These three objectives may be reached by several different types of operative procedure. The following are those most commonly employed.

(1) Manipulation: Employed when the capsule and ligaments are the chief cause of joint deformity.
(2) Capsuloplasty: Employed when the capsule and ligaments are the chief cause of joint deformity.
(3) Synovectomy: Employed: (a) To remove a focus of infection; (b) when there is extensive involvement of the synovia and articular cartilages, and a badly damaged but salvageable joint.
(4) Arthroplasty: Employed to restore motion in ankylosed but important joints.
(5) Arthrodesis: Employed when joint damage is so complete as to preclude the restoration of useful function in a joint where stability is more important than movement.

Manipulation.—Manipulation, although it has fallen into some disrepute because it is so often confused with the cult of osteopathy, is a very important part of the armamentarium of the surgeon. It is particularly useful in the correction of the less severe arthritic joint deformities, due to contracture of the ligaments, capsule, and muscles without serious joint damage. Manipulation, always carried out under an anesthesia, should employ only gentle maneuvers; rough and forcible manipulation, as a rule, excites a severe local reaction, which usually results in a rapid return of deformity and decreased joint motion. Following manipulation, carefully supervised active movements should be started within 12 to 24 hours, and the range increased from day to day in order that full advantage may be taken of the improved position and range of movement in the joint. It is, as a rule, undesirable to fix in plaster a joint which has been manipulated; and if such fixation is carried out, it should be for only a few days. If a joint is immobilized longer, there

is danger of losing much of the movement gained by manipulation. Traction is much better than plaster for fixation purposes. Manipulation is best adapted to the correction of mild contractures of the knee, shoulder, wrist, and feet.

Capsuloplasty.—Patients with chronic arthritis show a decided tendency to develop flexion contractures of the joints, especially the knee, hip, elbow, and fingers. Such flexion contractures result from the patient's attempts to ease pain by maintaining the joint in a position which gives the greatest relaxation to the capsule. As time goes on, a fibrosis and thickening of the capsule takes place, its elasticity is lost, and it becomes an unextensible, fibrous band, which holds the joint fixed in flexion, resists efforts at correction, and tends to draw the joint back into deformity, even if a certain amount of correction is obtained. Later, the muscles on the flexor aspect of the joint shorten and add to the deforming force. Under such conditions, attempts to overcome flexion deformity by manipulation are doomed to failure, or if accomplished by the use of great force, ankylosis usually results. The deformity can be overcome, however, in such joints, and a useful amount of joint movement preserved by the operation known as capsuloplasty. This operation has for its purpose lengthening the contracted joint capsule sufficiently to allow complete extension of the joint without the use of force. To perform such a capsuloplasty, on the knee joint, for example, lateral incisions are made on the sides of the joint, and the posterior compartment of the knee is entered. The capsule will be found to be thickened and closely adherent and plastered to the distal end of the femur and the proximal end of the tibia, practically obliterating the posterior joint space. The adherent joint capsule and ligaments are carefully and thoroughly stripped from the lower end of the femur and the upper end of the tibia for a distance of from six to eight inches or more. When this has been accomplished, the capsule will be found to be quite relaxed, and the knee can usually be brought into complete or nearly complete extension with the use of little force. After closure of the wound, a plaster encasement may be applied or traction employed to hold the knee in extension and overcome what slight residual flexion deformity may remain—we prefer traction. Motion should be started in a week and the range rapidly increased. If the contraction has been a right angle or an acute angle, full extension should not be attempted at the time of the operation but secured gradually by traction. Both vessels and nerves have become shortened, and too rapid extension will shut off the blood supply and interfere with nerve conductivity, either of which may cause disastrous results. Capsuloplasty on contracted knee joints which prevent standing and walking will enable the individual to become ambulatory. The operation is also useful in the correction of contracture of the elbow and fingers.

Synovectomy.—By synovectomy is meant the complete removal of an hypertrophied and diseased synovial lining which interferes with joint function. This procedure is of chief practical interest in the knee, since it has a large synovial surface which is easily accessible. The operation as applied

to the knee consists in opening the joint widely by a parapatellar incision, dissecting out in its entirety the synovia of the anterior compartment of the knee, the removal of both semilunar cartilages, excision of all articular cartilage which has become eroded by the joint pannus, and carefully shaving off the degenerated superficial layer of the articular cartilage, which is considered sufficiently normal to be allowed to remain. The last step, removing all seriously damaged cartilage and shaving away all the degenerated superficial layer of the remaining cartilage, is most important, as pointed out by Magnuson, if a maximum of joint function is to be obtained. Contrary to the opinion of a number of observers, it is our belief that a synovectomy, performed in a complete way, is one of the most useful surgical procedures available for overcoming pain and disability in arthritic joints, provided the cases are properly selected. The type of case which benefits most from a synovectomy is the so-called villus arthritis, which is characterized by a boggy, swollen knee, fixed in a greater or less degree of flexion so that standing and walking are difficult or impossible. A properly performed synovectomy followed by carefully supervised after-care gives, in such cases, surprisingly satisfactory results, both as regards relief of pain and the return of useful function. Furthermore, in a very considerable proportion of cases operated upon, it rids the patient of a source of infection which is a chronic focus for propagating the disease. This latter contention has been denied by many qualified to hold an opinion. Too often, however, in our experience, have active and acutely painful elbow, shoulder, and wrist joints subsided after synovectomy has been performed on the knee joint and remained quiescent and improved in function, to allow us to accept any other point of view than that the removal of such a focus has a very beneficial effect on the systemic disease in a very considerable number of cases. Without attempting to be critical, it might be a proper reply to the doubters to say, "You did not perform a thorough synovectomy." Synovectomy is one exception, so far as we can determine, to the rule that the disease must become quiescent before surgery is resorted to, as it may be performed, and in villus arthritis should be performed, when moderate activity is still present. In addition to the knee joint, synovectomy is satisfactorily undertaken in the elbow, wrist, and ankle joints. In 64 synovectomies, performed upon 45 patients in our clinic, the results have been as follows:

Total number of operations	64
Excellent results	38 or 59.3%
Definite improvement	13 or 20.3%
Failures	6 or 9.3%
Results unknown	5 or 7.8%
Too early to determine	2 or 3.11%

In 27 patients in this series, with polyarthritis, synovectomy has been followed by complete subsidence or definite improvement in other involved joints in 22 cases, or 86.6 per cent.

Arthroplasty.—The operation of arthroplasty consists in making a new joint to replace one rendered stiff and immovable by arthritis. Such an artifi-

cial joint is produced by resecting a considerable amount of bone, reshaping the bone ends entering into the joint in such a manner as to allow motion in normal planes, and placing between the bone ends some tissue, usually fascia lata, to prevent recurrence of the fusion between them. The after-treatment consists in carefully supervised physical therapy. Arthroplasty should never be performed upon an arthritic joint until it is quiescent and has been so for at least six months. Formerly, arthritic cases were not considered suitable for arthroplasty. In recent years, however, it has come to be considered a very useful and beneficial form of surgery under proper conditions, since it gives a useful, movable joint in a high percentage of cases. Restoring motion to one or more joints frequently enables an almost helpless individual to become reasonably active; for example, to feed himself when ankylosed elbows have been given movement. The elbow joint gives the most satisfactory result from an arthroplasty—the knee yields excellent results also. The hip joint was considered to be a very unsatisfactory joint for arthroplasty until Venable and Smith-Petersen introduced the Vitallium cap. Since then, very satisfactory results are being obtained. At the present time, in both the monarticular hypertrophic type of arthritis of the hip and in ankylosis due to atrophic arthritis, the results of arthroplasty, using a Vitallium cap are so promising that it bids fair to replace arthrodesis of the hip joint which has, up to the present time, been the operation of choice in this type of case. The operation of arthroplasty is not simple, and the postoperative care is tedious and time-consuming. Therefore, great care should be exercised in selecting cases in which it is recommended.

Arthrodesis.—Arthrodesis is an operation designed to secure complete ankylosis in a joint which has but a limited range of motion, and what motion remains is painful. Though arthrodesis takes away motion, it substitutes a strong, rigid, painless segment of limb for a painful and poorly functioning one, and the presence of a stiff joint, if the joints above and below are movable, is not as incapacitating as it is generally believed. Although it is desirable that the joints proximal and distal to that arthrodesed be normal, some impairment of these joints is not a contraindication to the procedure, as frequently, function in the adjoining joints improves following arthrodesis, probably due to the relief from strain and reflex muscle contractures. The success of the operation hinges upon ankylosing the limb in the optimum position of usefulness, and in securing a firm, bony fusion; this latter is not always as simple as it may seem. However, with an adequate technic, use of a bone graft, and a sufficiently prolonged postoperative immobilization, ankylosis can nearly always be obtained. The greatest field of usefulness for arthrodesis is in the knee, wrist, and hip.

CONCLUSIONS

It may be said in conclusion that most patients affected with arthritis sooner or later reach a stage of quiescence; when this stage has been reached, surgery may be resorted to to correct disabling joint deformities, relieve pain

for which they are responsible, and improve function. By employing one or more of the procedures which we have been discussing, it is usually possible, in properly selected cases, to restore useful function to one or more joints and thereby convert an invalid into an individual who can take care of himself and even become self-supporting. The number of persons seemingly incapacitated by chronic arthritis who are salvageable through surgery is large, and failure to give such patients the benefit of surgery is denying them an opportunity for improvement to which they are entitled. The purpose of this presentation is to indicate the pathway along which reconstruction may progress and to suggest a reevaluation of the arthritic cripple generally from the point of view of saving, through reconstruction surgery, something from the wreck which disease has left.

DISCUSSION.—DR. CHARLES S. VENABLE (San Antonio, Tex.): As usual Doctor Dickson has covered a very large territory and said a great deal. I am particularly interested in the salvage of those unfortunates who are on their way to ankylosis, and who hope and pray for it in order to get away from a painful joint, or have come to have an arthrodesis performed.

Doctor Dickson showed one case with a Vitallium cup on the hip. It was my good fortune to put on the first or second Vitallium cup. It is interesting, because it is the only material we know of which is sufficiently passive in the tissues not to cause other disturbances. Dr. Kellogg Speed has devised one for the head of the radius, and Dr. Willis Campbell has one for the knee. The difficulty in the knee is still the question of production of periarticular tissue, which looks good in the beginning and then tends to deteriorate during the course of thickening. I have done two of the head of the humerus, which seems to be a good place.

The whole story is, as I said, one of salvaging these unfortunate individuals who have had to be put in the discard, from both the humanitarian and economic standpoint.

DR. PAUL B. MAGNUSON (Chicago): Doctor Dickson has given us a very brief but concise idea of what he can do in the care of these various types of arthritis. The field is so large that it is practically impossible to do more than scratch the top. There are two distinct classes of arthritis to be considered; one is destructive arthritis—the rheumatoid type with thickened synovial membrane and destruction of the joint cartilage; the other is the hypertrophic or degenerative form.

We have obtained most impressive results in the degenerative form of arthritis which, in my opinion, is due to the sum total of the wear and tear of life on joints. When we say sum total, it is quite apparent that a number of causative factors must be taken into consideration. This is a condition which occurs in the latter half of life, not as rheumatoid arthritis, which usually occurs in the first half of life. Low-grade infection, toxemia, overweight, faulty weight-bearing, previous injury—all are contributing factors and all must be taken into consideration in the diagnosis. Toxemias, whether they be due to metabolic disturbances or intestinal disturbances, must be eliminated. Low-grade infections, which pour nitrogenous toxins into the system, must also be eliminated. It is my opinion that many of these patients become progressively worse even after the systemic causative factors have been eliminated, because the joint is already rough, and the continuation of the trauma of movement

on the rough joint surfaces continues to irritate the joint and makes the disease progressive.

We have opened more than 80 of these joints, 63 of them being in the degenerative type of arthritis, and have removed the irritating material. Every bit of rough cartilage and all the exostoses have been thoroughly cleaned out, even down to bare and bleeding bone. The joint has been brought back into proper weight-bearing line and early motion is started after operation.

There are two distinct types of degeneration in this particular phase of arthritis. One type starts on the surface of the cartilage and progresses toward the matrix. This seems to be confined to cases which are purely traumatic in origin, from faulty weight-bearing, injury, overweight, or some mechanical factor, but it progresses to complete erosion and degeneration of cartilage if it is allowed to do so. We have been able to reproduce this type of arthritis in dogs, by causing faulty weight-bearing or instability of the joint, and allowing the animal free range to run; the disability does not occur if the animal is kept in close confinement where the joint is not traumatized by active motion.

The other type of degeneration starts at the matrix and progresses toward the surface, and is cone-shaped with the apex pointing toward the surface. The degenerative area is much wider at the base and there are no healthy cartilage cells growing from the matrix. When the degeneration reaches the surface a fissure is formed, and the edges of the surrounding cartilage degenerate and become rough, with stringy fibrous tissue protruding into the joint like seaweed. We have not been able to reproduce this type of degeneration in animals, so far. The experimental work is still in progress. This type, we believe, is tied up in some way with nutritional factors. It does not always occur on weight-bearing surfaces first, as does the other type of degeneration. It may appear anywhere in the joint, although usually more severe on the weight-bearing surfaces, probably because of the friction caused by motion.

The fact remains that in both these types most startling results are obtained when all this rough material is cleared away, and we believe that joint débridement will give highly satisfactory results if properly and carefully done, even in patients of advanced age.

DR. FRANK DICKSON (Kansas City, Mo., closing): I personally owe a great deal to both Doctors Venable and Magnuson, for what I have been able to do with some of these arthritic joints. I merely wish to say that most arthritic cases sooner or later reach a stage of quiescence, and at this time by properly planned surgical attack on one or more joints, it is frequently possible to restore an arthritic cripple to comfortable living and sometimes to economic independence. The number of persons seemingly incapacitated by chronic arthritis who are salvable through surgery is large, and failure to give such patients the benefit of surgery is denying them an opportunity for improvement to which they are entitled. It would then seem worth while to reevaluate our arthritic cripples generally, from the point of view of saving, through reconstruction surgery, something from the wreck which the disease has left.

BRIEF COMMUNICATION AND CASE REPORT

SPONTANEOUS RUPTURE OF THE COMMON BILE DUCT*

E. DUNBAR NEWELL, M.D.

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A THOROUGH REVIEW of the literature shows very few reported cases of this interesting condition. A large majority of the cases that have been reported are early or late sequelae of operative procedures upon some portion of the biliary duct system. Several reports were also found of traumatic ruptures of the bile ducts; we were, however, able to find only two references to spontaneous rupture of the common bile duct not associated with trauma, operation, or impacted stone in the duct, namely, one by Bailey,[13] and the second by Vale and Shapiro.[4]

We have found several discussions of biliary peritonitis following transudation, or "weeping," of bile from either the duct system, the gallbladder, or from the bile radicals under the capsule on the surface of the liver. However, we feel that this diagnosis is not plausible unless the condition is actually observed, and that the etiology differs from the case herein reported.

Case Report.—W. G. T., white, male, age 63, was referred by Dr. D. O. Wright, of Fort Payne, Ala. His family and personal history were essentially irrelevant. He had had an appendicectomy in 1926; and had had mild diabetes for the past ten years. *Chief Complaint:* Severe pain in the abdomen.

Present Illness.—The patient had been under the care of a physician for the past three years, during which time he had had at least eight attacks of severe epigastric distress and digestive disturbance, followed on several occasions by mild jaundice. Relief was obtained by rest in bed and the dietary measures usually employed in gallbladder disturbances. Between attacks, the patient's only complaint was eructation and mild dyspepsia, bearing no relation to his meals or other natural functions. Occasionally, during the attack of acute pain, he required a hypodermic of morphine for relief; however, the pain at no time lasted longer than 12 to 24 hours. Occasionally, during an attack, he complained of pain under the right scapula.

The last attack, prior to the present illness, was two weeks previous to admission to the hospital, following which he stayed in bed two days and recovered without undue difficulty. The present attack occurred 30 hours before admission; the initial pain occurring below the right costal margin and extending rapidly over the enitre abdomen. He was examined, immediately following the attack, by his physician who stated that the attack was no different from the others from which he had suffered previously, and the usual rest, diet, and medication were advised and administered. However, ten hours following the onset of the attack, the patient vomited a large quantity of bright red blood and, when examined on this occasion, he presented board-like rigidity of the abdomen. Immediate hospitalization was refused. The patient continued to vomit and continued to have severe pain in his abdomen. He consented to hospitalization 30 hours following the initial attack of pain.

* Read before the Fifty-third Annual Session, Southern Surgical Association, Hot Springs, Va., December 10, 11, 12, 1940.

Physical Examination.—The patient is an asthenic white male, age 63, conscious, rational, and acutely ill. Pulse 80; blood pressure 180/100. Examination was otherwise negative except for that relevant to the abdomen. This showed an old appendicectomy scar. There was board-like abdominal rigidity, with tenderness over the entire abdomen, most marked in the epigastrium. Uranalysis was normal, except for a trace of sugar. W.B.C. 13,250, 83 per cent neutrophils. The patient was given 1,000 cc. of glucose intravenously; and immediate operation was advised. *Preoperative Diagnosis:* Ruptured peptic ulcer.

Operation.—Under cyclopropane anesthesia, the abdomen was opened through a right upper midrectus incision. There was an immediate gush of bile-stained fluid. The pylorus was found to be normal. The stomach showed no indication of pathology. Palpation of the head and body of the pancreas revealed no evident abnormality. The gallbladder was small, approximately one-third normal size, thick-walled, with surrounding dense, fibrous adhesions. It contained no stones or bile; there was, however, a small amount of white fluid. It apparently had not functioned for a number of years. The common duct was exposed and found to be dilated to approximately four times normal size, throughout its entire visible length. Further inspection revealed a small bile-discolored effusion beneath the peritoneum, overlying the common duct at approximately the junction of the common hepatic and cystic ducts. An incision was made through this peritoneum and a small amount of bile escaped. However, careful inspection showed no evidence of any opening into the common duct. An adequate incision was then made in the common duct, the walls of which were thickened and edematous. A large amount of common duct "mud" was obtained and several small cholesterol stones, approximately 2 Mm. in diameter. Following cleansing of the common duct, a probe was easily passed into the hepatic ducts, and a large blunt dilator was, also, easily passed through the sphincter of Oddi into the duodenum. Very little resistance was met during this maneuver and no stones were encountered. The cystic duct was found to be completely occluded by scar tissue. The common and hepatic ducts were washed out with saline solution. A small catheter was sutured in place in the common duct. The gallbladder was removed. A rubber tissue drain was placed down to the gallbladder bed and catheter, and brought out at the middle of the wound. The wound was sutured in layers. The patient was returned to bed in moderate shock, from which he recovered rapidly.

Postoperative Course.—Convalescence was fairly smooth; and the catheter was removed 12 days following operation. The biliary fistula healed rapidly. He was discharged 20 days following operation, apparently in excellent condition.

Follow-Up.—One year following operation: Excellent condition. No epigastric discomfort. Has gained approximately 15 pounds in weight, and apparently is perfectly well and healthy.

COMMENT.—Several interesting features present themselves in regard to the pathology in this patient. The case is undoubtedly one of bile peritonitis following an acute, spontaneous rupture of the common duct. However, at the time of operation, we found no indication of obstruction in any point in either the common or hepatic ducts which might account for a rupture of the duct from undue pressure. The liver, examined carefully at the time of operation, presented no evidence of chronic hepatitis or injury from partial common duct obstruction. The patient at no time, throughout his history or during his hospitalization, had any clay-colored stools, severe jaundice, or any indication of complete obstruction of the common duct.

We believe that the gallbladder was nonfunctioning, and that the dilatation of the common duct may be explained on the basis that the function of the gallbladder was assumed by the common duct following atrophy of the former. The small stones and common duct "mud" found at operation may easily have been accounted for by the stasis in the common duct, inci-

dent to its dilatation. The only plausible explanation we can offer for rupture of the common duct is that the patient had a chronic choledochitis with an acute exacerbation, and edema or spasm of the sphincter of Oddi, causing temporary partial obstruction and a subsequent empyema of the common duct, with rupture occurring at the weakest point in its infected wall. Another possibility is that this patient had a small stone imbedded in the wall of the common duct with surrounding infection causing acute perforation.

Burden[6] in 1925, in a paper on "Histologic and Pathologic Anatomy of Hepatic, Cystic, and Common Bile Ducts," probably found the correct explanation for the perforation which must have existed in this case. His original study on the anatomy of the extrahepatic bile ducts indicates that these structures may well be subject to intrinsic pathology. He has shown that the biliary ducts contain numerous glands in their walls, extending almost to the peritoneal coat. Normally, these glandular structures are filled with mucous secretion, however, it seems entirely plausible that in a dilated, diseased duct, the glands might well be the site of infection or calculus formation, which, under unusual circumstances, would lead to perforation of the duct.

The conditions found at operation seemed to be quite similar in all reported cases.

Bailey[13] describes his case as follows:

"Pints of bile were found in the peritoneal cavity. Bile was also present in the lesser sac and behind the peritoneum, which was floated up. The gallbladder looked normal, but on palpation many tiny calculi could be felt. The stomach and duodenum were examined with a negative result. The cystic duct and supraduodenal portion of the common duct were examined with a seeker, but no perforation was demonstrable; indeed, these structures appeared quite normal. It is concluded that there was a perforation of some part of the hepatic or common bile ducts. Cholecystotomy and drainage of peritoneum were performed. Twelve hours later, he collapsed and died. A necropsy showed a perforation at the back of the junction of the cystic and common ducts."

Quoting further from Bailey:

"Biliary peritonitis without perforation was first described by Clairment and Haberer, in 1910. Professor Leriche records a case in which three pints of bile were found in the general peritoneal cavity. Bile was found to be dripping from a distended gallbladder. The pathology of the condition is obscure. The gallbladder in these cases is found to be very edematous and Marinacci believes that there is a minute perforation or perforations in its wall. This theory is plausible and should be assumed to be correct until further evidence concerning this rare condition is forthcoming."

In our case, there was no edema of the gallbladder, and no dripping of bile from the gallbladder.

The other case that is analogous to the one herewith reported, was that of Vale,[4] of Detroit, who stated:

"The gallbladder was chronically inflamed with thickened walls, and was filled with innumerable small stones. There was no point upon it which leaked bile. The stomach and duodenum were normal. The peritoneum covering the common duct, portal vein, and hepatic artery, was edematous, evidently having been dissected up by the presence of escaping bile somewhere beneath it."

He drained this case through the gallbladder and cystic duct; and the patient made a good recovery.

In the reported cases, the patients presented more or less the following picture: A history of acute, severe pain in the epigastrium, followed by vomiting, with a history of previous epigastric discomfort, resembling the present attack but not so severe; there may or may not be jaundice; when

first seen by the physician, these patients usually present a picture of a chemical peritonitis, with board-like rigidity of the entire abdomen, and tenderness directly over the epigastrium. The obvious diagnosis, and the one most frequently made, is ruptured peptic ulcer.

The only instance in which the rupture was actually located appeared to be at the autopsy table. As these patients are very ill, operation must be carried out rapidly, and as these perforations are usually very small, location at the time of operation would be needless and most difficult.

Of the two cases found in the literature, one survived and one died. The operative procedure in both cases was similar, the primary thought being to drain either the gallbladder or the common duct itself. No follow-up reports of these two cases were found.

SUMMARY.—A case of nontraumatic, nonobstructive, spontaneous rupture of the common bile duct is reported; with comments on two previously reported instances in the literature.

BIBLIOGRAPHY

[1] Bumpus, H. D., Jr.: Rupture of the Common Bile Duct Associated with Subphrenic Abscess. ANNALS OF SURGERY, 64, 414, October, 1916.

[2] Garrett, R. W.: Traumatic Rupture of the Bile Duct. ANNALS OF SURGERY, 31, 227, 1900.

[3] Long, Le R.: Traumatic Rupture of the Bile Ducts. South. Med. Jour., 22, 236, March, 1929.

[4] Vale, C. F., and Shapiro, H.: Nontraumatic Perforation of Common Bile Duct. Am. Jour. Surg., 18, 103, October, 1932.

[5] Wolfson, W. L., and Levine, D. R.: Spontaneous Rupture of the Common Bile Duct. Surg., Gynec., and Obstet., 60, 746, March, 1935.

[6] Burden, Verne G.: Observations on the Histologic and Pathologic Anatomy of the Hepatic, Cystic, and Common Bile Ducts. ANNALS OF SURGERY, 82, 584, 1925.

[7] Rudberg, H.: Traumatic Rupture of the Biliary Passages. J.A.M.A., abstract, 79, 1562, October 28, 1922.

[8] Lewis, K.: Traumatic Rupture of the Bile Ducts. ANNALS OF SURGERY, August, 1938.

[9] Newburger, B.: Spontaneous Postoperative Rupture of the Bile Ducts. ANNALS OF SURGERY, 107, 558, April, 1938.

[10] Lysaght, A. C.: A Case of Traumatic Severance of the Common Bile Duct. British Jour. Surg., 646, January, 1939.

[11] Caulfield, E.: Bile Peritonitis in Infancy. Am. Jour. Dis. Child., 52, 1349, December, 1936.

[12] Allen, A. W., and Wallace, R. H.: The Surgical Management of Stone in the Common Bile Duct. Trans. South. Surg. Assn., 52, 167, 1939.

[13] Bailey, Hamilton (Eng.): Emergency Surgery. Vol. I, 103. Wm. Wood and Co., 1930.

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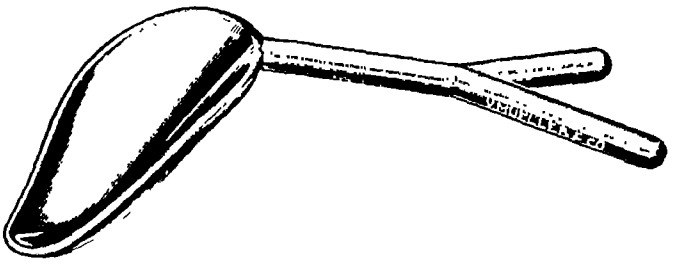
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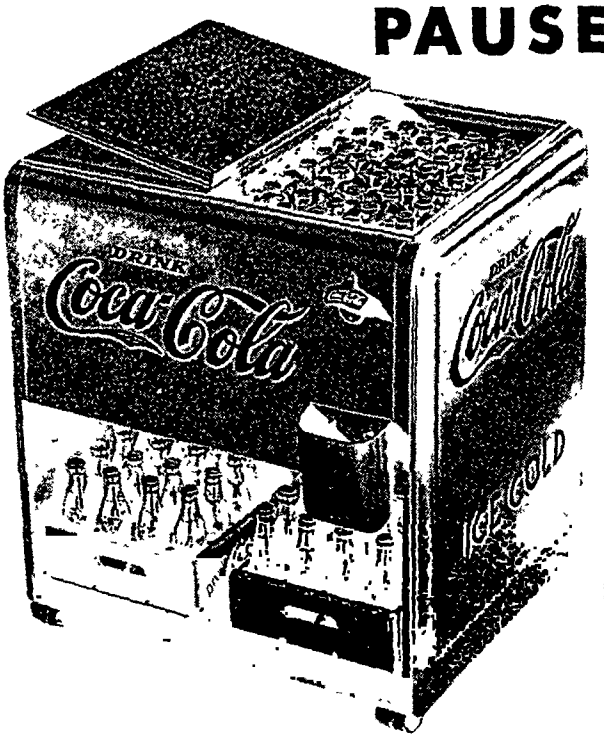
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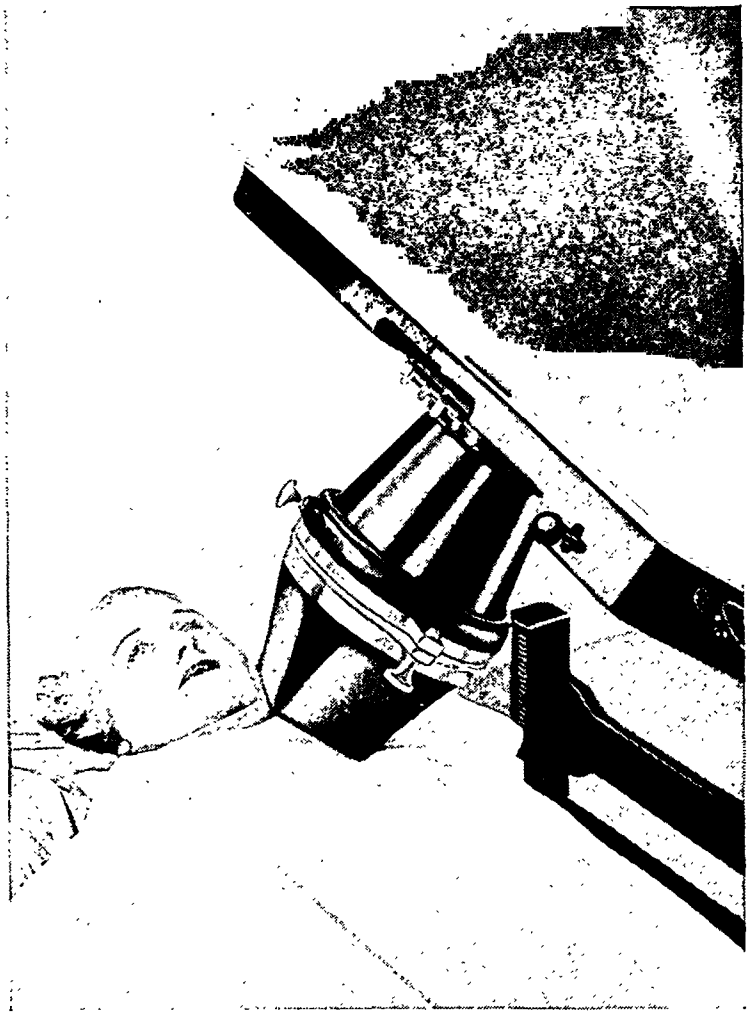


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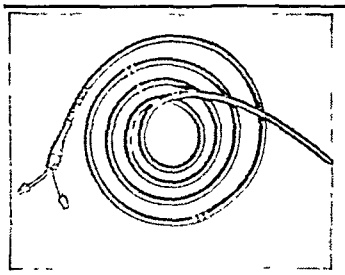
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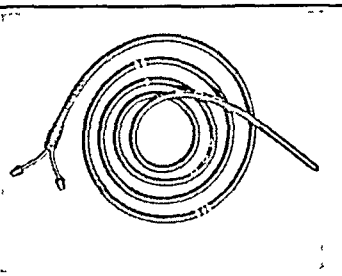
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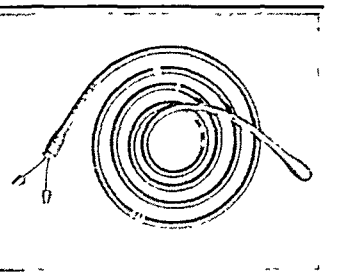
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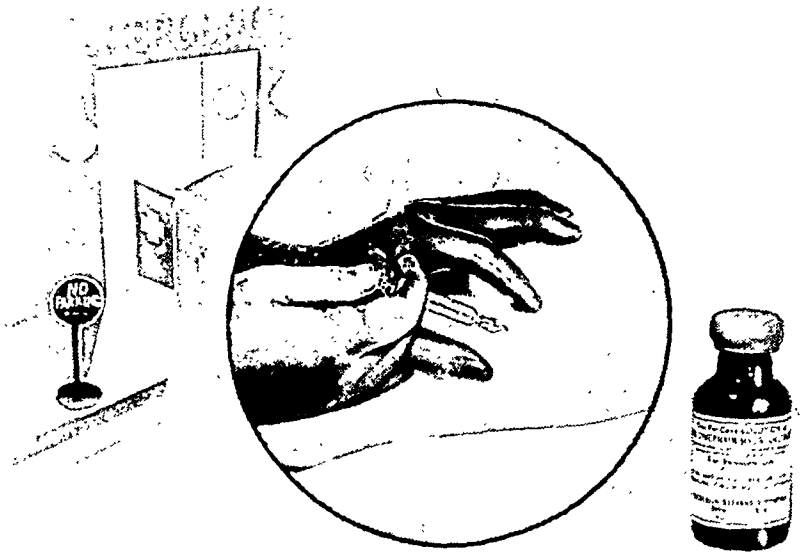
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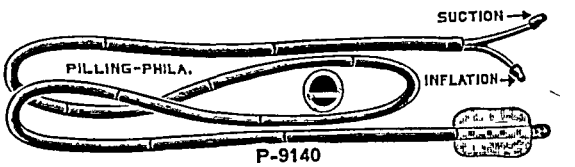
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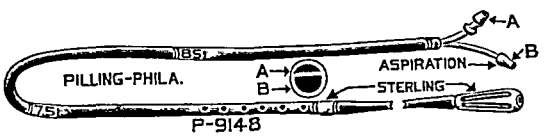
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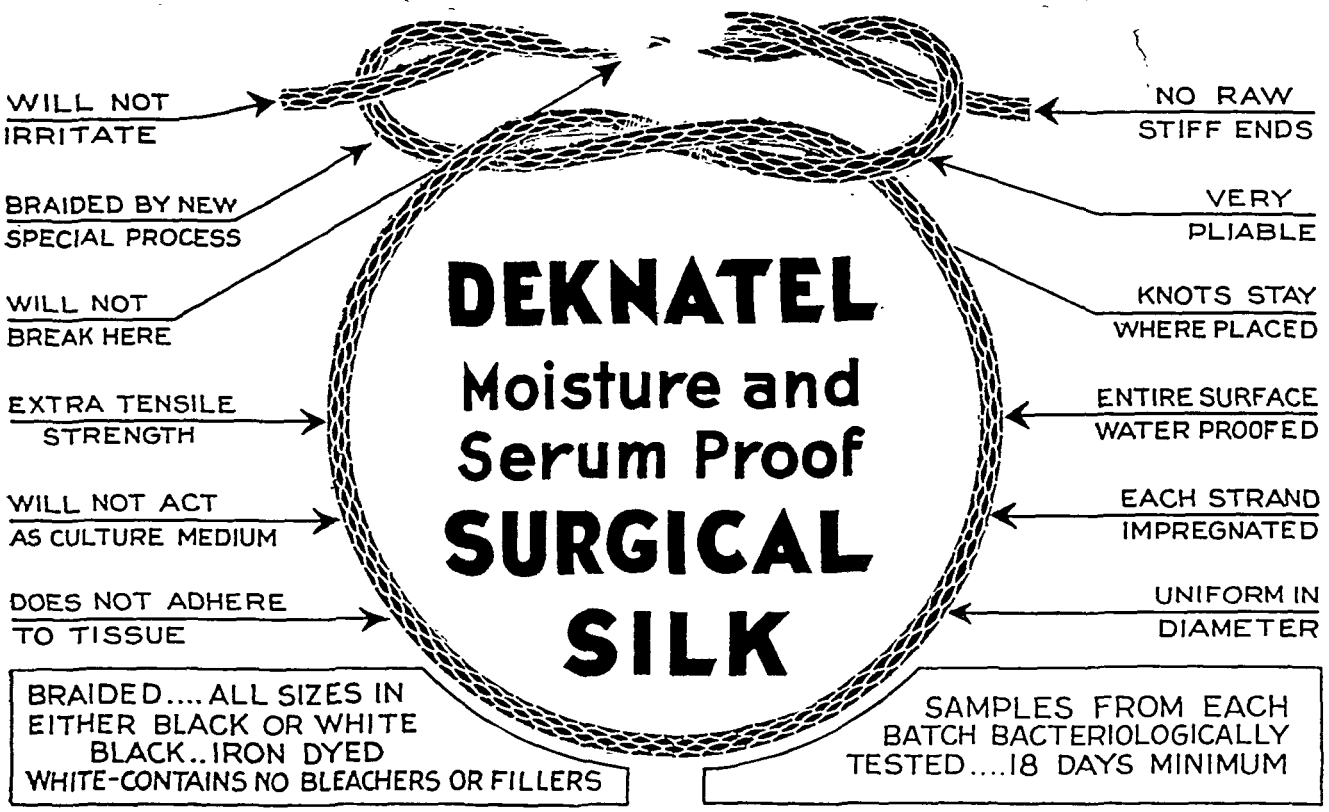
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